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National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities Regulated Under RCRA (Resource Conservation and Recovery Act) in 1981

Westat, Inc., Rockville, MD

Prepared for

Environmental Protection Agency, Washington, DC

20 Apr 84

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- FINAL REPORT -

NATIONAL SURVEY OF HAZARDOUS WASTE GENERATORS AND TREATMENT, STORAGE AND DISPOSAL FACILITIES REGULATED UNDER RCRA IN 1981

Submitted to:

The Environmental Protection Agency
Office of Solid Waste
401 M Street, S.W.
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April 20, 1984

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20 Apr 84

by S. Dietz, M. Emmet, R. DiGaetano, D. Tuttle, and C Vincent.

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The report presents results of extensive statistical survey of hazardous waste handlers regulated under the Resource Conservation and Recovery Act in 1981. Survey procedures and statistical reliability are documented. Major findings are presented, including best estimates of the number of regulated generaters.

KEYWORDS: *Generators, *Hazardous wastes, *Solid waste disposal, *Waste treatment.

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TABLE OF CONTENTS

Section Page

EXECUTIVE SUMMARY 1

PART I

1 INTRODUCTION 9

1.1 Background on the RCRA Hazardous Waste Regulatory Program............................ 10
1.2 The Need for a National Survey 12
1.3 Scope and Focus of the Survey 15

2 SURVEY METHODOLOGY 21

2.1 Questionnaire Design............................ 21
2.2 Pre-Survey Screening: Development of the Sample Frame.................................. 24
2.3 Sample Design................................... 26
2.4 Data Collection................................. 31
2.5 Quality Control................................. 32

2.5.1 Response Rate Quality Control.......... 32
2.5.2 Nonsampling Error Quality Control...... 34
2.5.3 Editing of Large Quantity Cases in the Component Data Files.................. 35

2.6 Imputation Procedures Used for Quantity Estimates.. 36

3 STATISTICAL RELIABILITY AND DATA ACCURACY.......... 39

3.1 The Concepts of Sampling Error and Nonsampling Error...................................... 39
3.2 Response Rates and Sample Sizes.............. 40
3.3 Statistical Reliability and Sampling Error.... 42
3.4 Nonsampling Error 53

PART II

INTRODUCTION TO PART II: NUMBERS OF HAZARDOUS WASTE GENERATORS AND MANAGEMENT FACILITIES......... 55

4 NUMBER OF HAZARDOUS WASTE GENERATORS............... 57

4.1 Regional Distribution of Generators........... 61
4.2 Number of Generators by Industry Type........ 65
4.3 Number of Generators by Waste Group Generated. 66
4.4 Number of Generators Shipping Hazardous Waste Off Site....................................... 69
4.5 Number of Generators Recycling Hazardous Waste.. 71

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TABLE OF CONTENTS (continued)

Section Page

5 DEFINITION AND NUMBER OF MANAGEMENT FACILITIES..... 75

5.1 Regional Distribution of Hazardous Waste Management Facilities.......................... 78
5.2 Number of Management Facilities by Industry Type.. 82
5.3 Number of Commercial Management Facilities.... 83
5.4 Number of Facilities Treating, Storing, and/or Disposing of Hazardous Waste................. 87

5.4.1 Number of Facilities Treating Hazardous Waste, by Treatment Process Type.......................... 92
5.4.2 Number of Facilities Storing Hazardous Waste, by Storage Process Type.......................... 97
5.4.3 Number of Facilities Disposing of Hazardous Waste, by Disposal Process Type.......................... 100

5.5 Miscellaneous Facility Characteristics........ 103

5.5.1 Age of Waste Management Facilities..... 103
5.5.2 Ownership Status of TSD Facilities..... 106
5.5.3 Operator Status of TSD Facilities...... 107

PART III

INTRODUCTION TO PART III: QUANTITIES OF HAZARDOUS WASTE GENERATED AND MANAGED......................... 109

6 QUANTITIES OF HAZARDOUS WASTE GENERATED............ 121

6.1 1981 Hazardous Waste Generation Estimates..... 123
6.2 Size Distribution of Generators.............. 138
6.3 Quantities Generated by Industry Type......... 139
6.4 Quantities of Hazardous Waste Generated by Type of Waste Group.......................... 143
6.5 Disposition of Quantities Generated: Managed On Site Versus Off Site...................... 144
6.6 Recycling of Quantities Generated by Location of Recycling Facilities...................... 151
6.7 Future Hazardous Waste Generation Regulated Under RCRA.................................. 153

7 QUANTITIES OF HAZARDOUS WASTE MANAGED............. 159

7.1 Quantity of Waste Managed as Hazardous by TSD Facilities in 1981.......................... 162

TABLE OF CONTENTS (continued)

Section

Page

7.2 Size Distribution of TSD Facilities........... 166
7.3 Comparison of Quantities of Hazardous Waste Generated and Managed.......................... 166
7.4 Quantities Managed by Industry Type........... 175
7.5 Quantities Managed by Type of Waste Group..... 176
7.6 Quantities Managed by Commercial Management Facilities.................................. 183
7.7 Quantities of Hazardous Waste Treated, Stored and Disposed During 1981..................... 185

7.7.1 Quantities of Hazardous Waste Treated in 1981, by Treatment Process Type..... 189
7.7.2 Quantities of Hazardous Waste Stored in 1981, by Storage Process Type....... 197
7.7.3 Quantities of Hazardous Waste Disposed in 1981, by Disposal Process Type...... 204

PART IV

8 CAPACITY OF TREATMENT, STORAGE AND DISPOSAL FACILITIES...................................... 211

8.1 U.S. Capacity Utilization: Commercial and On-Site Management Facilities................ 213
8.2 Regional Utilization of Existing Capacity..... 218
8.3 Unused Capacity by Region.................... 220
8.4 Summary and Conclusions About Available Capacity..................................... 224

PART V

9 NEXT STEPS: FUTURE HAZARDOUS WASTE STUDIES........ 225

9.1 Mail Survey Followup Activities............... 226
9.2 Updates and Expansions to Mail Survey Data Base... 227
9.3 Continuing Analysis of Mail Survey Data....... 227
9.4 Small Quantity Generators Study............... 228
9.5 Survey of Used Oil and Waste-Derived Fuel Material..................................... 228
9.6 Industry Studies.............................. 229
9.7 RCRA Biennial Report.......................... 230

TABLE OF CONTENTS (continued)

Section | | Page
APPENDIX A: SAMPLE DESIGN AND STATISTICAL RELIABILITY..... A-1

APPENDIX B: FIELD REPORT.................................. B-1

APPENDIX C: SELECTED REGULATIONS IMPLEMENTED UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976, AS AMENDED............................ C-1

APPENDIX D: SUMMARY OF MAJOR DATA ELEMENTS CONTAINED IN COMPUTER DATA BASE FROM THE NATIONAL SURVEY OF RCRA-REGULATED GENERATORS AND MANAGEMENT FACILITIES................................. D-1

LIST OF TABLES

Table | Page
1 Special Edit Coverage of the Largest Facilities in Each Component Data File........................ 37
2 Number of Eligible Responses and Response Rates to the RCRA Survey.................................. 41
3 Statistical Reliability of Estimates from the Generator and TSD General Questionnaire........... 48
4 Number of Respondents and Statistical Reliability of Estimated Percentages, by Process Type......... 51
5 "K" Factors to Be Used in Obtaining 95 Percent Confidence Intervals for Population Subsets....... 52
6 Characteristics of Nonregulated Notifiers that Responded to the Survey........................... 59
7 Comparison of Notifier and Generator Distributions in EPA Regions.................................. 62
8 Percent of 1981 Hazardous Waste TSD Facilities in EPA Regions - By Rank Order...................... 80
9 Percentage of Treatment Facilities and of All TSD Facilities Employing Each Treatment Technology in 1981...................................... 96
10 Percentage of Storage Facilities Employing Each Storage Technology in 1981......................... 102
11 Percentage of Disposal Facilities and of all TSD Facilities Employing Each Disposal Technology in 1981.. 105
12 Age Distribution of TSD Facilities................ 106
13 Ownership Status of TSD Facilities................ 107
14 Operator Status of TSD Facilities................. 107
15 Quantity Distribution for Commercial and Other Types of TSD Facilities........................... 184

LIST OF TABLES (continued)

Table Page

16 Total Quantities Managed, Average Quantities Managed per Facility and Number of Facilities Treating, Storing and Disposing of Hazardous Waste in 1981 187

17 Total Quantities Treated, Average Quantities Treated and Number of Facilities Treating Hazardous Waste by Each Treatment Process Type.... 192

18 Size Distributions in the Treatment Technologies: Proportions of the Population Accounting for 33 Percent of the Quantities of Waste Treated in Each Technology 193

19 Total Quantities, Average Quantities Stored and Number of Facilities Storing Hazardous Waste by Storage Process Type 200

20 Size Distributions in the Storage Technologies: Proportions of the Population Accounting for 33 Percent, 50 Percent and 99 Percent of the Quantities of Waste Stored in Each Technology..... 203

21 Total Quantities Disposed, Average Quantities Disposed and Number of Facilities Disposing of Hazardous Waste by Each Disposal Process Type..... 207

22 Size Distributions in the Disposal Technologies: Proportions of the Population Accounting for 33 Percent, 50 Percent and 99 Percent of the Quantities Waste of Disposed in Each Technology... 208

23 Summary of 1981 U.S. "Commercial" and On-Site Hazardous Waste Management Capacity Utilization... 214

24 Distributions of Unused Capacity Over Facilities for Treatment, Storage and Disposal of Hazardous Waste 217

LIST OF TABLES (continued)

Table		Page
A-1	Summary of Statistical Aspects of the TSD and Generator Surveys	A-6
B-1	Generator Questionnaire Return Status	B-13
B-2	Eligibility Rate Among Respondents From the Notifier File and the Part A/Verification File	B-18
B-3	Return Status for TSD and Component Questionnaires	B-22
B-4	Eligibility Rates for the Treatment, Storage, and Disposal Questionnaire and the Technology Questionnaires	B-23

LIST OF FIGURES

Figure Page

1 Purpose of Survey.................................... 16

2 Survey Scope... 19

3 Distribution of Management Facility Size........... 45

4 Comparison of Cumulative Distributions of Quantity of Hazardous Waste Managed in 1981 and the Number of Management Facilities........................... 46

5 Portion of Notifiers That Generated RCRA-Regulated Quantities of Hazardous Waste in 1981.............. 60

6 Regional Distribution of Hazardous Waste Generators in 1981... 63

7 Number of Generators by Industry Type.............. 65

8 Number of Establishments Generating Each Major Waste Group... 67

9 Number of Generators Shipping Hazardous Waste Off Site in 1981...................................... 70

10 Number of Generators Recycling Hazardous Waste..... 72

11 Regional Distribution of Hazardous Waste Management Facilities in 1981............................... 79

12 Number of Management Facilities by Industry Type... 82

13 Number of Commercial Versus Other TSD Facilities... 86

14 Number of Facilities with Treatment, Storage, and/or Disposal in 1981............................... 89

15 Number of Facilities Treating Hazardous Waste in 1981, by Treatment Process Type.................... 95

16 Number of Facilities Storing Hazardous Waste in 1981, by Storage Process Type...................... 101

17 Number of Facilities Disposing of Hazardous Waste in 1981, by Disposal Process Type................. 104

18 Overlap Among Populations of Generators and TSD Facilities Regulated Under Subtitle C of RCRA...... 129

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LIST OF FIGURES (continued)

Figure		Page
19	Overlap Among Generator and TSD Samples and Among Eligible Respondents........................	131
20	Estimates of the Quantity of Hazardous Waste Generated in 1981....................................	135
21	Quantities of Hazardous Waste Generated in 1981 by Industry Type..................................	141
22	Waste Group Percentage Comparisons Between the 1981 Generator and TSD General Surveys............	145
23	Disposition of Hazardous Waste Generated: Quantity Managed On Site vs. Shipped Off Site for Management..	146
24	Hazardous Wastes Recycled in 1981.................	152
25	Quantity of Waste Managed as Hazardous Wastes by TSD Facilities in 1981...........................	164
26	Comparisons of Cumulative Distributions of Quantity of Hazardous Waste Managed in 1981 and the Number of TSD Facilities......................	167
27	Quantity Generated Versus Managed.................	169
28	Description of Quantities Generated by Generators Without TSD Facilities and Quantities Received from Off Site by TSD Facilities..................	172
29	Quantities of Hazardous Waste Managed in 1981 by Industry Type....................................	177
30	Quantities of Hazardous Waste Handled by Management Facilities in 1981 by Type of Waste Group.........	180
31	Quantities of Hazardous Waste Treated, Stored and Disposed in 1981..................................	186
32	Quantities of Hazardous Waste Treated in 1981, by Treatment Process Type...........................	190
33	Quantities of Hazardous Waste Stored in 1981, by Storage Process Type.............................	198

LIST OF FIGURES (continued)

Figure Page

34 Quantities of Hazardous Waste Disposed in 1981, by Disposal Process Type............................ 205

35 1981 Average Facility TSD Capacity Utilization Rates, by Region.................................. 219

36 1981 Regional Unused Treatment Capacity........... 221

37 1981 Regional Unused Storage Capacity............. 222

38 1981 Regional Unused Disposal Capacity............ 223

39 Future Studies.................................... 232

B-1 TSD Questionnaire Returns by End of Each Month From September 17, 1983 Mailout. RCRA Required Return Date: November 15, 2,599 Packages Mailed.. B-8

B-2 Notifier Generator Returns by End of Each Month From September 17, 1983 Mailout. RCRA Required Return Date: November 15, 10,667 Packages Mailed. B-9

B-3 Return Status Codes and Definitions............... B-11

B-4 Titles of the Nine Questionnaires that were Mailed with the Treatment, Storage, and Disposal Questionnaire.................................... B-21

ABBREVIATIONS

EPA	Environmental Protection Agency
HWDMS	Hazardous Waste Data Management System
MMT	Million metric tonnes
NEC	Not elsewhere classified
NPDES	National Pollutant Discharge Elimination System
NSK	Not specified by kind
OSW	Office of Solid Waste (EPA)
Part A	Part A of EPA's Consolidated Hazardous Waste Treatment, Storage, and Disposal Facility Permit Application
POTW	Publicly owned treatment works
PPS	Probability of selection proportionate to size
RIA	Regulatory Impact Analysis (required under Executive Order 12291)
RCRA	Resource Conservation and Recovery Act of 1976, as amended
SIC	Standard Industrial Classification (Code)
TSD	Treatment, storage, and disposal (facility)

CONVERSION FACTORS
USED FOR HAZARDOUS WASTE

243.9025	Gallons per English (short) ton
268.8519	Gallons per metric tonne
0.00371952	Metric tonnes per gallon
0.9072	Metric tonnes per English (short) ton
1.102293	English (short) tons per metric tonne
0.0041	English (short) tons per gallon

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EXECUTIVE SUMMARY

This report summarizes the findings of an extensive national survey of hazardous waste generators and treatment, storage, and disposal facilities regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. The survey, conducted by mail during the fall of 1982 and the spring of 1983, was administered by Westat under the sponsorship and direction of the United States Environmental Protection Agency's (EPA) Office of Solid Waste (OSW).

Preliminary findings of the survey were released by EPA on August 30, 1983, in a package entitled: "Highlights of Preliminary Findings, National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA During 1981." Since that time, Westat, in conjunction with OSW, performed additional editing of the obtained data, leading to the development of Version II of the survey data base. Additionally, the findings presented in this report are based upon a revised approach for estimating total quantities of hazardous waste generated. The information presented in this report, therefore, supersedes information previously released from the survey data base.

The information developed through the survey provides EPA and other participants in the hazardous waste decisionmaking arena with the first complete description of hazardous waste generation and management activities regulated under Federal law since enactment of RCRA by Congress in 1976. The survey produced a statistically weighted data base containing more than 6,000 statistical data elements describing hazardous waste generation and management activities in 1981, the study year. The findings presented in this report are drawn from only a portion of these data, but are intended to provide a broad overview of the nature and scope of the populations of regulated hazardous waste generators and treatment, storage, and disposal facilities and of the hazardous wastes they generate and manage.

The survey's most important finding is that an estimated 71 billion gallons (264 million metric tonnes) of hazardous wastes were generated during 1981, more than six times previous estimates of annual hazardous waste generation. It is important to highlight the fact that this 71 billion gallon estimate differs considerably from the preliminary survey findings released by EPA on August 30, 1983. When the survey results were initially tabulated, the quantity of hazardous waste generated during 1981 was preliminary estimated to have been 40 billion gallons (approximately 150 million metric tonnes). Extreme statistical uncertainty, however, was associated with that preliminary estimate. At that time, EPA believed (and indicated in its public presentation of the preliminary findings) that the 40 billion gallon estimate had a greater likelihood to understate rather than overstate, the actual quantity of hazardous waste generated in 1981. Subsequent to the release of the preliminary findings, further analysis of the data obtained through the independent surveys of generators and the TSD facilities revealed that the 40 billion gallon estimate did indeed substantially understate the actual quantity of hazardous waste generated. Accordingly, an alternate approach was developed, using additional data obtained through the survey, to estimate the actual quantity generated, and resulted in the survey's final estimate of 71 billion gallons of hazardous waste generated in 1981.

Large portions of this quantity are mixtures of hazardous and nonhazardous wastes (e.g., hazardous wastes mixed with industrial process waters), although the survey data do not estimate the actual amounts of such mixtures, nor the concentrations of specific constituents included in such mixtures. The mixtures included by the survey are, however, hazardous wastes as defined under RCRA, and are therefore properly included in the estimate of hazardous waste generation.

It is important to note, however, that this survey was not designed to estimate the quantity of all hazardous wastes generated during 1981. The 71 billion gallon estimate includes only those hazardous wastes generated in 1981 that were to be managed in treatment, storage, and disposal processes regulated under RCRA. Additional quantities of hazardous wastes were also generated during 1981 that were treated, stored, or disposed of in processes exempt from regulation under RCRA (e.g., hazardous wastes treated exclusively in wastewater treatment tanks covered under NPDES permits, which are excluded from regulation under RCRA). Furthermore, additional quantities of wastes were generated in 1981 that have been specifically excluded by statute and/or regulation from classification as hazardous waste, even though they may exhibit characteristics of hazardous wastes [e.g., wastes generated in conjunction with ore and minerals extraction and beneficiation; wastes legitimately disposed of through sewers to Publicly Owned Treatment Works (POTW's)]. The survey was not designed to estimate these quantities, for reasons explained in the sections that present the quantity estimates.

Prominent among the survey's other findings are the estimated numbers of generators and treatment, storage, and disposal (TSD) facilities regulated under RCRA during 1981. The survey estimates that 14,098 installations generated RCRA-regulated quantities of hazardous waste during 1981, compared to more than 55,000 installations that have submitted generator Notification forms to EPA pursuant to Section 3010(a) of RCRA. Similarly, the survey estimates that 4,818 facilities treated, stored (for more than 90 days), or disposed of hazardous wastes in processes regulated under RCRA during 1981, compared to the more than 8,000 facilities that currently have Part A permit applications on file at EPA. The survey, however, purposefully excluded specific classes of TSD facilities from its estimate, as detailed in the report sections presenting the TSD facility population estimates.

Analyses of data obtained by the survey indicate that the distributions of the populations of hazardous waste generators and TSD facilities are each highly skewed along their relative size spectra. Specifically, each population includes a small number of sites that account for a very large portion of the quantities of hazardous wastes generated or managed. These large sites dominate the quantity estimates provided in the report, and their presence within the populations complicates efforts to develop statistically reliable estimates of the quantities of hazardous waste generated and managed annually. The impact of these large sites on the reliability of the obtained data is detailed in the report sections presenting the quantity estimates.

The survey found that while most generators (84%) shipped some or all of their hazardous wastes off site for treatment, storage, and disposal during 1981, the overwhelming majority of the quantity of hazardous waste (96%) was managed on site. The report attributes this phenomenon to the fact that the larger generators tend to manage their hazardous wastes on site, while the more numerous smaller generators, for various reasons, ship their wastes to commercial facilities for treatment, storage, and disposal.

The survey found that the number of generators that recycle hazardous waste is increasing with time, with more than 50 percent of the 14,098 generators indicating that they intended to recycle hazardous waste in years following 1981 (compared with just over 40 percent recycling in 1980 and 43 percent recycling during 1981). The survey also found, however, that only a small portion of the hazardous waste generated in 1981 was actually used, reused, recycled, or reclaimed, indicating that in most cases, generators recycle only small portions of their hazardous waste streams. It should be pointed out, however, that many other generators are exempt from RCRA because they recycle 100 percent of certain hazardous waste streams. The survey purposefully excluded such generators and waste streams from its estimates. Furthermore, the comparison of quantities recycled with total quantities generated is skewed by the inclusion of large quantities of hazardous and nonhazardous waste mixtures in the data base. Frequently, only small portions of such mixtures (e.g., the particular hazardous constituents) are actually recyclable.

Hazardous waste generators and management facilities were found to be concentrated in manufacturing industries. Eighty-five percent of the 14,098 generators and 72 percent of the 4,818 TSD facilities are estimated to be associated with industrial manufacturing operations (Standard Industrial Classification Codes 2000 through 3999). Manufacturing industries accounted for an even greater portion of the total quantity of hazardous waste generated in 1981 (92%). The chemical industry alone (SIC code 28) is estimated to have accounted for 68 percent of the amount generated in 1981.

The survey found that treatment represented the most prevalent hazardous waste management technique during 1981. It is important to note, however, that treatment quantities appear to be most heavily affected by mixtures of hazardous and nonhazardous wastes (in particular, mixtures of hazardous wastes with industrial process waters). Comparison of such quantities with quantities of hazardous wastes landfilled, for example, may therefore be misleading, since the quantities entering landfills tend to contain substantially higher concentrations of hazardous constituents. Furthermore, a greater degree of uncertainty surrounds the estimates of treatment quantities, as explained in detail in the sections presenting these estimates.

The survey estimates that approximately 14.7 billion gallons of hazardous wastes were disposed of during 1981, with underground injection observed as the most dominant disposal mechanism, accounting for nearly 60 percent (approximately 8.6 billion gallons) of the total quantity disposed. Large portions of this quantity were mixtures of hazardous and nonhazardous wastes, however, presenting similar comparison problems to those described above for the treatment quantities. Landfills were found to outnumber all other disposal sites (199 landfill sites, versus only 88 injection well sites), and accounted for 807 million gallons of the 14.7 billion gallons of hazardous waste disposed. Nearly 500 million gallons of hazardous wastes are estimated to have been incinerated during 1981, representing just over half the quantity that was landfilled.[1]

The survey estimates that there were 326 commercial TSD facilities operating during 1981, accounting for 1.3 billion gallons of hazardous waste management. While small in comparison to the total quantity generated, shipments by generators to commercial TSD facilities represented 82 percent of the total quantity of hazardous waste shipped off site in 1981. The survey's definition of a commercial facility is one that is privately owned and operated, where more than 50 percent of the hazardous waste managed during the year was received from firms under different ownership. Expanding this definition to include any facility that manages hazardous waste for a fee, the definition of "commercial" employed by OSW, the survey estimates that 509 such facilities were operational during 1981.

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[1] This 0.5 billion gallons is not part of the 14.7 billion gallons disposed since incineration is classified by RCRA as a treatment process.

Finally, estimates from the survey indicate that the total amount of annual unused capacity across the United States was more than sufficient to accommodate the treatment, storage, and disposal requirements for quantities of hazardous waste generated at 1981 levels. TSD facilities reported utilizing only 36 percent of total disposal capacity during 1981, and reported utilizing less than one-quarter (23%) of their hazardous waste treatment capacity that year. Large, on-site management facilities, however, dominated the national capacity picture, and may obscure potential capacity shortages among the more numerous smaller facilities. Unused capacities were also distributed unevenly across EPA regions, with Region IV accounting for nearly 60 percent of unused disposal capacity and Region V accounting for just under half of the nation's unused treatment capacity. Furthermore, commercial facilities, which represent "available" capacity, account for only small portions of the total unused treatment and disposal capacities.

This report represents the completion of a three year effort by OSW to improve its regulatory and general decisionmaking information base. The survey data base will provide valuable information to decisionmakers concerning hazardous waste management practices regulated under RCRA over the coming years. In addition, OSW is currently engaged in a number of studies to improve its information base in specific issue areas, including surveys of potential small quantity generators and handlers that burn wastes in boilers and as fuels, and an ongoing series of industry studies. OSW is also preparing to receive state by state summaries of the 1983 Biennial Reports that were submitted by hazardous waste generators and TSD facilities in the spring of 1984. These reports and their summaries, will provide OSW with a continuing flow of important, valuable data upon which its future regulatory decisions may be based.

PART I (Sections 1–3)

INTRODUCTION

AND

METHODOLOGY

1. INTRODUCTION

This report summarizes the findings of an extensive national survey of hazardous waste generators and treatment, storage and disposal facilities regulated under Subtitle C of the Resource Conservation and Recovery Act of 1976, as amended. The survey, conducted by mail during the fall of 1982 and the spring of 1983, was sponsored and directed by the United States Environmental Protection Agency's Office of Solid Waste (OSW). The survey was administered by Westat Research, Incorporated, a national survey research firm based in Rockville, Maryland. Westat provided technical assistance in designing the survey, implementing it, and analyzing its results under EPA contract 68-01-6621.

The survey was national in scope and involved the development of 10 questionnaires containing more than 6,000 individual statistical data elements. The data obtained from the 11,714 respondents answering one or more of these questionnaires are capable of providing statistical estimates of the magnitude, scope, and nature of hazardous waste generation and management activities regulated under Federal law during 1981. This report, developed by Westat for submission to the Office of Solid Waste, details the development of the survey, the procedures followed in its conduct, and provides analyses and a summary of information compiled from major portions of the obtained data.

The body of this report is organized into five major parts composed of nine sections in all. Readers desiring a brief overview of this report highlighting the major findings should refer to the Executive Summary immediately preceding this section. Part I (Sections 1-3) contains the introduction to the report and the methodology. Part II (Sections 4 and 5) presents the findings on the numbers of hazardous waste generators and management facilities described in various ways by the survey. Because the statistical reliability of these data was generally very good due to the survey design, they are presented separately from the quantity data. Quantities generated and managed are presented within their own less precise context in Part III (Sections 6 and 7). Part IV (Section 8) contains an analysis of national and regional capacity for managing hazardous waste. Part V (Section 9) describes future EPA studies in the hazardous waste area. More detailed information on the methodological approach, the survey data base, and key regulatory requirements is found in the appendices

1.1 Background on the RCRA Hazardous Waste Regulatory Program

With its enactment of the Resource Conservation and Recovery Act of 1976 (RCRA) and in its subsequent amendments thereto in 1978 and 1980, Congress required the Environmental Protection Agency (EPA) to promulgate a regulatory program ensuring adequate protections to human health and the environment in the generation, transportation, and management of hazardous wastes. RCRA was enacted by Congress to address the growing national problem of waste generation and disposal, compounded by rapidly developing industrial production and pollution abatement technologies and the use of increasingly complex chemicals and materials in the production of goods and services demanded by our society.

Section 3010(a) of RCRA required all hazardous waste handlers to notify EPA of their hazardous waste management activities by August 18, 1980 (90 days after EPA promulgated regulations identifying and listing hazardous wastes). Among other things, Subtitle C of RCRA required EPA to:

- Promulgate regulations identifying the characteristics of hazardous waste and listing particular wastes to be regulated as hazardous wastes under RCRA (§3001);
- Establish a manifest system for "cradle-to-grave" tracking of hazardous waste shipments (§3002);
- Establish standards governing the generation (§3002), and transportation (§3003) of hazardous wastes;
- Promulgate regulations to ensure proper treatment, storage, and disposal of hazardous wastes, including the promulgation of standards governing the location, design, construction and operating procedures of hazardous waste treatment, storage, and disposal (TSD) facilities (§3004);
- Grant "interim status" (temporary permits) to all TSD facilities that were "in existence" on November 19, 1980 and that (1) complied with the Notification requirements of Section 3010(a), and (2) submitted Part A Hazardous Waste Permit Applications to EPA by November 19, 1980 (§3005(e));
- Issue final permits to new and existing TSD facilities as a mechanism for applying the facility standards developed under §3004 to individual facilities (§3005); and,
- Promulgate guidelines to assist States in the development of State hazardous waste programs, and to grant interim and final authorization for qualified State programs to administer the RCRA hazardous waste regulatory program in lieu of the Federal program, including the issuance and enforcement of permits for the storage, treatment, and disposal of hazardous wastes.

Between February 1980 and July 1982, OSW promulgated the major components of the hazardous waste regulatory program called for by Congress in its enactment of RCRA. Hazardous wastes to be regulated under RCRA were identified by characteristic and listed specifically; a "cradle-to-grave" manifest system was implemented; refinements to the definitions of regulated hazardous waste generators and treatment, storage, and disposal facilities were established, including the definitions of certain exempt or partially exempt handlers such as "small quantity" generators, ninety-day on-site "accumulators," and certain treatment facilities already regulated under the National Pollutant Discharge Elimination System (NPDES); and, finally, TSD facility permitting and operating standards were issued in stages to govern most processes used to treat, store, or dispose of hazardous wastes.

Based upon EPA's lists and definitions of hazardous wastes and its definitions of regulated handlers, the Agency received nearly 70,000 Notification forms in response to §3010(a) of RCRA from firms indicating they were handling or might in the future handle hazardous wastes regulated under RCRA. Of these, nearly 60,000 indicated that they were or might in the future be hazardous waste generators. The remaining Notification forms indicated hazardous waste transportation, treatment, storage, or disposal, and underground injection that were not located at the same site as generators. Furthermore, nearly 15,000 of these firms also submitted Part A permit applications to EPA, indicating that they would be treating, storing, or disposing of hazardous wastes regulated under RCRA.

1.2 The Need for a National Survey

Initial analyses of information submitted on Notification forms and Part A applications provided EPA with its first picture of the range of industrial and other activities, as well as of the types of firms and organizations that would be regulated under Subtitle C of RCRA. Notifications of hazardous waste generation and applications for its subsequent treatment, storage, and disposal were received from nearly every sector of American industry, as well as from an equally broad spectrum of firms and organizations engaged in service-oriented (as opposed to production-oriented) activities, including municipal, State, and Federal government agencies. Further analyses of these initial sources of data provided EPA with indications of the numbers and types of processes used to treat, store, or dispose of hazardous wastes; the general geographic distribution of hazardous waste generators and TSD facilities; and rough indications of the quantities and types of hazardous wastes that would be managed by these firms.

As EPA continued in its development of the various aspects of the RCRA regulatory program, however, the need increased substantially for more detailed information describing the characteristics, scope, and magnitudes of the populations of hazardous waste generators and TSD facilities regulated under RCRA. In particular, Executive Order 12291 required EPA to conduct extensive regulatory impact analyses (RIA's) of its existing and pending regulations governing hazardous waste management practices. The RIA's combine human health and environmental risk assessments with benefit/cost analyses to assess the probable impacts of existing or pending regulations. Executive Order 12291 requires RIA's to be performed for all "major rules": regulations and standards that are expected, among other things, to have significant ($100 million or more) impacts on the economy. Most of the regulations that comprise EPA's RCRA hazardous waste program meet the definition of major rules and are therefore required to be analyzed extensively.

In addition to the requirements of Executive Order 12291, EPA required more information about the specific processes used to manage hazardous wastes in order to complete its development and evaluation of the facility standards required under RCRA to ensure adequate protections for human health and the environment in the treatment, storage, and disposal of hazardous waste.

Furthermore, as EPA began managing the regulatory program it created, its need for management information increased accordingly, including the need to determine more precisely the nature and numbers of generators and facilities actually regulated under RCRA and the quantities of hazardous wastes annually generated and managed in the United States. Finally, EPA received increasing numbers of requests from Congress, industry groups, research and development firms, environmental organizations, and the public at large for reliable information about hazardous waste management activities regulated under RCRA, information that was largely unavailable from existing data sources.

Accordingly, OSW began in the summer of 1981 to develop an extensive national statistical survey of RCRA-regulated hazardou waste generators and treatment, storage, and disposal facilities. OSW's purpose in conducting the survey was essentially three-fold:

- The primary purpose of the survey was to characterize the populations of hazardous waste generators and TSD facilities regulated under Subtitle C of RCRA that were actively generating regulated quantities of hazardous waste or treating, storing, or disposing of hazardous waste in processes regulated under RCRA during 1981. The population of hazardous waste handlers indicated by submissions of Notification forms and Part A permit applications included substantial numbers of firms that were not actually managing hazardous waste at that point in time, and many that were not actually subject to or affected by the RCRA regulations. Thus, the survey focussed on identifying the size of the population of active handlers in a given calendar year, 1981.

- The second purpose of the survey was to develop a national data base on hazardous waste management practices for use by OSW and others in the continuing development and evaluation of the RCRA regulatory program and in assessing its impact on the regulated community, pursuant to Executive Order 12291. This included gathering cost data pertaining to hazardous waste operations.

- The final purpose of the survey was to estimate the magnitude and scope of hazardous waste generation and its treatment, storage, and disposal in the United States. Previous estimates of the quantity of hazardous waste generated annually had varied substantially and were often based upon information from limited segments of the RCRA-regulated population or upon secondary data. As a secondary objective, this survey was intended to provide a baseline estimate of the quantities of hazardous waste generated and treated, stored, and disposed of during 1981 in processes subject to the RCRA regulations using primary data obtained from a statistically valid sample of facilities regulated under RCRA.

Figure 1 on the accompanying page summarizes the above-stated purposes for conducting the National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981.

1.3 Scope and Focus of the Survey

The survey was designed to be national in scope, covering hazardous waste generation and management activities in all 50 States, as well as Puerto Rico, Guam, and the Virgin Islands. Information obtained through the survey instruments focussed almost exclusively on 1981 calendar year hazardous waste management activities. Calendar year 1981 was selected as the study year because it was the first complete calendar year following the implementation of the RCRA regulatory program, and because it was the most recent year for which complete calendar year data were available from respondents at the time the survey was actually conducted.

The focus of the survey was limited to those hazardous waste handlers and those hazardous waste management activities regulated under Subtitle C of RCRA during 1981. As a result,

Figure 1

PURPOSE OF STUDY

- Characterize hazardous waste handlers regulated by RCRA:
  - Generators
  - Treatment, storage, and disposal facilities
- Develop data base to support:
  - Regulatory development
  - Regulatory impact analyses
  - Regulatory review
- Estimate 1981 hazardous waste quantities:
  - Generated
  - Treated
  - Stored
  - Disposed

the survey design excluded certain hazardous waste generators and TSD facilities or processes that have been specifically exempted from regulation under RCRA, including: small quantity generators (installations that generate less than 1,000 kilograms per month of hazardous waste or less than 1 kilogram per month of acutely hazardous waste); processes used to treat hazardous wastewaters under National Pollutant Discharge Elimination System (NPDES) permits where the treatment occurs exclusively in tanks; storage tanks and container storage areas used exclusively for the on-site accumulation of hazardous wastes for up to ninety days prior to their treatment, disposal, or shipment off site; and publicly owned treatment works (POTW's) as defined by §502(4) of the Clean Water Act. The survey also excluded generators and TSD facilities where it was determined that the only hazardous wastes they generated or managed during 1981 had been delisted by EPA (even if the delisting occurred after 1981), and generators of specific waste streams that beneficially used or recycled all of their wastes on site.

Furthermore, generators and TSD facilities or processes that did not actively generate or treat, store, or dispose of hazardous wastes during the 1981 calendar year were also excluded from the survey, even though they may well have been subject to regulation under RCRA during that period of time. As an example, a landfill into which hazardous wastes were placed during December of 1980, but into which hazardous wastes were not input at any time during 1981, would have been excluded from the survey, even though the landfill was regulated under RCRA due to its use as a hazardous waste disposal mechanism subsequent to the implementation of the RCRA regulatory program.

The focus of the survey was designed with these restrictions in order to produce a "snap shot" of RCRA-regulated hazardous waste management activities actually occurring in a given calendar year. EPA believed that significant numbers of firms that submitted Notification forms and Part A permit applications were not actually generating regulated quantities of hazardous waste or treating, storing, or disposing of hazardous wastes in processes regulated under RCRA (see the description of Westat's telephone verification efforts in the discussion of pre-survey screening efforts in Section 2.2). Thus, as stated in Section 1.2, one of the primary purposes of the survey was to estimate the numbers of regulated generators and TSD facilities that were actively engaged in regulated hazardous waste management activities during 1981.

Finally, the survey did not include any hazardous waste generators or TSD facilities subject to the RCRA regulatory program, but who had not complied with the RCRA §3010(a) Notification requirements and who therefore handled hazardous wastes during 1981 in violation of the law. Accordingly, it is beyond the scope of this report to try to assess the magnitude of illegal hazardous waste generation and management activities occurring in 1981 or in any other year.

The various factors affecting the scope and focus of the survey are summarized in Figure 2 on the accompanying page and are discussed in greater detail in the substantive sections of this report and in the survey field report contained in Appendix B.

Figure 2
SURVEY SCOPE

- National Survey of Hazardous Waste Handlers
- 1981 hazardous waste activities only
- Only those who registered with EPA (Notifiers and Part A permit)
- Only RCRA covered hazardous waste management, therefore design excludes:
    - Small generators
    - 90-day accumulators
    - Wastewater treatment in tanks
    - Publicly owned treatment works
    - Delisted wastes
    - Other exempted handlers and waste streams

2. SURVEY METHODOLOGY

This section of the report provides an overview of the design and development of the survey, together with a brief description of the steps and procedures followed in actually conducting the survey. The information presented in this section and the next section on statistical reliability, is intended to provide readers with a basic understanding of the structure of the survey, how it was conducted, and how the findings presented in the remainder of the report should be interpreted. A more detailed account of the survey methodology is presented in the field report in Appendix B for those requiring more in-depth information.

2.1 Questionnaire Design

Beginning in the summer of 1981, OSW, in conjunction with Westat, conducted a series of information needs assessments to determine the specific nature of the data to be collected through the national survey. Information needs were found to differ considerably across the various aspects of OSW's development and management of the RCRA hazardous waste program. Three general categories of information needs did, however, emerge:

(1) Information describing various characteristics of the populations of hazardous waste generators and TSD facilities regulated under RCRA;

(2) Information relating to the quantities of RCRA-regulated hazardous wastes generated and treated, stored, and disposed; and,

(3) Information relating to the costs of hazardous waste management activities.

Since the desired characteristics, cost, and quantity information differed considerably across the various processes used to treat, store, and dispose of hazardous waste, separate survey instruments (mail questionnaires) were developed for each process. In all, eight process-specific management technology questionnaires were developed for TSD facilities, namely:

- The Underground Injection Well Questionnaire;
- The Landfill Questionnaire;
- The Land Treatment Questionnaire;
- The Surface Impoundment Questionnaire (a single questionnaire was developed for treatment, storage, and disposal surface impoundments);
- The Waste Pile Questionnaire;
- The Incinerator Questionnaire;
- The Container Questionnaire; and
- The Tank Questionnaire (a single questionnaire was developed for storage and treatment tanks).

In addition, a Treatment, Storage, and Disposal General Questionnaire was developed for all TSD facilities. In effect, the TSD General Questionnaire is a compilation of the questions that are common to all TSD facilities, regardless of the types of management technologies they employ. Had OSW conducted a survey of landfills only, for example, the questionnaire that would have been developed would have included all of the questions in the Landfill Questionnaire and all of the questions in the TSD General Questionnaire. Similarly, if the survey had focussed exclusively on incineration, the questionnaire that would have been developed would have included all the questions in the Incinerator Questionnaire and all of the questions in the TSD General Questionnaire. Since many of the TSD facilities to be included in the survey were expected to provide information about more than one process, the TSD General Questionnaire was developed to eliminate the unnecessary duplication of questions in each of the process-specific management technology questionnaires.

A Generator Questionnaire was also developed to provide information relating to hazardous waste generation practices, as opposed to hazardous waste management (treatment, storage, and disposal) practices occurring after generation. All of the questionnaires were designed to obtain data relating to each of the three information categories defined above: characteristics data (e.g., whether or not the landfill was lined, whether or not the facility was located in a floodplain, the type of material used in constructing the surface impoundment, etc.); quantity data (e.g., quantity of hazardous waste generated, quantity of hazardous waste disposed of in landfill, etc.); and cost data (e.g., process-specific construction costs, facility labor rates, etc.). Cost questions were generally not included in the Generator Questionnaire, however, with the exception of general questions on the costs incurred by generators in sending their wastes off site for treatment, storage, or disposal.

In all, 6,202 statistical data elements were established in the 10 questionnaires. All of the data elements were designed to be fully automated, with closed-end answer category codes established for almost all questions, and precise question-specific instructions provided in an attempt to obtain clearly defined data from the respondents. The survey was designed to provide a functional data base for continuing analyses by various parties in the hazardous waste field, including EPA, its contractors, Congressional committees, and other interested parties. Many of the major data elements contained in the survey data base are described and summarized in the substantive sections of this report. A more extensive description of the survey data is provided in Appendix D.

2.2 Pre-Survey Screening: Development of the Sample Frame

OSW had originally intended to use the files of Part A permit applications and Notification forms maintained in EPA's Hazardous Waste Data Management System (HWDMS) as the frame for drawing statistical samples of generators and TSD facilities operating specific management technology processes during 1981. As indicated previously, however, OSW recognized that the Notification forms and, particularly, the Part A permit applications were designed to pertain to then current (1980) and future hazardous waste generators and TSD facilities. Since the objective was to survey only those sites that were active hazardous waste handlers during 1981, OSW was concerned that sampling from the Part A and Notification files would produce inefficient samples (i.e., the samples drawn from those files would include large numbers of firms that were intended to be excluded from the survey, thereby resulting in large numbers of "ineligible" respondents, smaller obtained data files for analysis, and reduced reliability in the statistical conclusions reached).

In response to these concerns, Westat conducted a small telephone survey of firms that filed Part A applications, and an even smaller telephone survey of firms that submitted Notification forms to EPA. The purpose of these surveys was to test the suitability of these two data files to serve as valid sample frames from which to select samples of sites that were actively engaged in regulated activities in 1981. The results of these surveys forced OSW to conclude that, indeed, the Part A file would not serve as a useful sample frame for the survey of TSD facilities actively engaged in regulated activities in 1981, due primarily to protective filings and erroneous filings by facilities not then subject to the RCRA regulations.

Westat was then instructed to construct a new sample frame by conducting telephone interviews with all TSD facilities that submitted Part A applications to determine the actual processes, if any, used in RCRA-regulated management of hazardous wastes during 1981. Westat was successful in completing interviews with approximately 85 percent of the nearly 9,500 facilities listed in the HWDMS Part A file during July and August of 1982. The results of this survey are summarized in Westat's "Report on the Telephone Verification Survey of Hazardous Waste Treatment, Storage, and Disposal Facilities Regulated Under RCRA During 1981." A hybrid file of telephone verified facilities and remaining uncontacted facilities on the Part A file was then established as the sample frame for the TSD facility sample. This hybrid sample frame is referred to in the remainder of this report as the "Part A/Telephone Verification" file.

The initial telephone interviews also suggested that an inefficient sample of the 1981 generators of regulated quantities of hazardous waste would result from the file of firms that submitted Notification forms indicating they were or might in the future be hazardous waste generators. In fact, the telephone interviews with firms that indicated generation on their Notification forms but that did not submit Part A applications identified an average of only one actual 1981 generator of regulated quantities of hazardous waste out of every 20 interviews. Therefore, in order to successfully use the Notification file as the sample frame for 1981 generators, oversampling was employed to assure that a sufficiently large number of 1981 generators would, indeed, be observed. The alternative was to conduct nearly 60,000 telephone verification interviews prior to conducting the mail survey, which would have been prohibitively expensive and time consuming.

2.3 Sample Design

As indicated in the introduction, the survey was intended to be national in scope. Accordingly, the samples of generators and TSD facilities were designed to produce nationally reliable statistical results. Essentially, the samples fall into two categories:

- A sample of TSD facilities, comprising eight subsamples of facilities corresponding to the various process type questionnaires, drawn from the Part A/Telephone Verification file; and
- A sample of generators, drawn partially from the Part A/Telephone Verification file (to observe generators that managed their waste on site) but primarily from the file of firms that submitted Notification forms (indicating generation) but did not file Part A applications (to observe generators that ship their hazardous wastes off site for treatment, storage, or disposal).

A total of 10,667 generators was selected from the Notification file to receive the Generator Questionnaire, and an additional 553 Generator Questionnaires were mailed to firms selected from the Part A/Telephone Verification file.[1] The total number of Generator Questionnaires mailed out, therefore, equaled 11,220. The generator samples were each stratified by industry type. Each frame was divided into three groups defined by combinations of Standard Industrial Classification (SIC) codes provided by OSW. (See Appendix A for a detailed description of the sample stratifications.) Furthermore, the samples were drawn so as to provide representation of generators in each EPA region in numbers proportional to the number of firms found in each region on the sample frame.

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[1] Note that the reason such a large number of generators was sampled from the Notification file was to compensate for the anticipated high proportion of nonregulated firms that would be included.

The sampling scheme developed and employed for TSD facilities, however, was considerably more complex. Separate independent random samples of facilities were drawn from the Part A/Telephone Verification file for each of the eight process-specific management technology questionnaires. Actually, 10 independent sampling lists were created from the Part A/Telephone Verification file: lists of facilities indicating that the process of interest (e.g., incineration) was used to manage hazardous waste during 1981 were created for seven of the eight process-specific management technology questionnaires; two such lists were created for the Tank Questionnaire (one list for storage in tanks, a second list for treatment in tanks); and, finally, a tenth list was created from which to select TSD facilities from the Part A/Telephone Verification file that also indicated that they generated hazardous waste. Since the telephone survey obtained size indicators for the processes confirmed to be used at facilities in 1981, each list was ranked by the appropriate size measure, and then random samples were drawn from each with a systematic selection procedure. It should be noted that the size-measure rankings were employed to assure proportional representation of hazardous waste handlers of all sizes, not as a mechanism to oversample large or small handlers.

Facilities that operated more than one type of waste management process in 1981 were included on as many lists as they had processes, and were thus eligible to be selected in more than one sample. In fact, many facilities were selected to receive at least two process-specific management questionnaires and a large number received even more (the survey design limited the maximum number of process-specific management technology questionnaires sent to a single site to four, plus a General Questionnaire). Finally, any facility selected from the Part A/Telephone Verification file to receive one or more process-specific questionnaires or the Generator Questionnaire also was required to complete the TSD General Questionnaire. As described in Section 2.1, the TSD General Questionnaire was designed to combine the questions common to all the process questionnaires, and thereby reduce the workload for respondents by eliminating the need to fill out duplicate answers in two or more process-specific questionnaires.

The resulting sample of TSD General Questionnaires was therefore selected with varying probability. The weighting technique used to account for the varying selection probabilities of sampled sites is described in Appendix A. A total of 2,557 TSD facilities were eventually selected through this multiple list selection process. An additional 42 facilities were subsequently added to the sample to compensate for an initial low response rate in one category, bringing the total number of facilities sampled, and therefore the total number of TSD General Questionnaires mailed out to 2,599. Section 3 provides specific sample size information for each of the process-specific management technology questionnaires, together with a presentation of the response rates and an assessment of the statistical reliability of the data obtained from all of the questionnaires.

The last sample design issue that requires discussion at this point in the report concerns the selection technique employed within each sample list, after the lists had been stratified by SIC code (generators) and process type (TSD facilities) organized by EPA region (generators and facilities), and ranked by size (TSD facility process lists). Once each list was organized, the actual sampling approach used was that of "equal probability of selection." As indicated in Section 1.2, OSW had a number of purposes in conducting the national survey, and desired to develop at least three distinct types of data: (1) characteristics data, such as estimates of actual numbers of regulated and active generators and TSD facilities, the proportion of landfills with liners, the proportion of incinerators employing rotary kiln technology, etc.; (2) cost data, such as estimates of the cost of installing liners in surface impoundments, the cost of sending hazardous waste to commercial facilities, the cost per ton to incinerate hazardous waste as opposed to disposing of it in a landfill, etc., and (3) quantity data, such as estimates of the total quantity of hazardous waste generated annually, the quantity of hazardous waste disposed of in landfills or injection wells, the quantity of hazardous waste recycled, etc.

The precision of statistical estimates in each of these three categories is sensitive to the sampling procedure employed in obtaining the data to be used in generating the estimate. Estimates of population characteristics are best served through the sampling technique employed in this survey: equal probability of selection (i.e., each facility on the sampling list has an equal likelihood of being selected to be included in the sample). Estimates in the quantity area and, to a lesser extent, the cost area are often better served through the use of selection probabilities that are proportionate to a relevant size measure (PPS sampling). With PPS selection, the larger facilities on the sample frame, or list, have a greater likelihood of being selected in the sample.

An equal probability sampling approach was employed in the national survey for two specific reasons. First, at the time the survey was being designed and developed, OSW placed greater priority on the ability to describe the characteristics of the RCRA-regulated population than it did on the ability to estimate the quantity of hazardous waste generated annually. OSW's primary motivation behind this allocation of priorities was that the regulatory impact analyses required under Executive Order 12291 are intended to assess the impact of regulations that require changes in the practices or the structures of facilities affected by them; that is, changes in the characteristics of the regulated population. Thus, greater emphasis had to be placed on obtaining reliable estimates of the characteristics of the regulated population, particularly since support for the RIA's was one of the primary purposes of the survey.

The second factor supporting the use of equal probability sampling in this survey was one of practicality: the alternative, probability of selection proportionate to size (PPS), requires that the sample frame contain reasonable size indicators for all, or most, of its members. OSW did not have access to any size indicators for the generators selected from the Notification file, since paperwork reduction requirements prevented a quantity question from being included on the Notification forms. Thus, PPS sampling was not possible for generators. Some size indicators, however, were available for the specific processes employed at TSD facilities, such as the quantity of hazardous waste incinerated, or the maximum size of the waste pile at any point during the year. These size indicators, however, were obtained for fewer than half of the facilities during the telephone survey. Furthermore, the size indicators obtained varied from process to process, and therefore did not provide a consistent size indicator for TSD facilities as a whole. Thus, the size data available for TSD facilities was considered inadequate for the use of PPS sampling selection.

The impact of equal probability sampling on the statistical reliability of the survey data will be discussed in Section 3.

2.4 Data Collection

The data for this study were collected using mail survey techniques, during a field period that lasted from fall 1982 to spring 1983. A set of 10 questionnaires was developed for data collection as described in Section 2.3.

The questionnaires were designed to be self-explanatory. Each question of each questionnaire contained its own instructions to the respondent. In addition, respondents were provided with an instruction booklet and three appendices of supplemental information. Also, technical assistance in the form of "hotline" telephone services was provided to respondents both by Westat and by the EPA's RCRA hotline. Approximately 4,000 calls were handled by the two hotline services combined. Finally, all quantity questions included in the survey questionnaires provided respondents with the ability to answer in units of measure of their choosing, thereby reducing the potential for respondent error in performing conversion into consistent units of measure. Westat then converted all quantity answers into consistent units by computer recodes.

The questionnaire packages (including the questionnaires, a cover letter, instructions, appendices, and a return envelope) were mailed to sampled facilities and installations during the first two weeks of September 1982. The respondents were instructed to complete and return their questionnaires to the Office of Solid Waste, Environmental Protection Agency, within 45 days of receipt of the questionnaire package. The cover letter indicated that time extensions beyond the 45 days' response time could be requested, and that respondents could request that information submitted in the questionnaires be treated as confidential business information.

Response rates for the questionnaires were high, which is to be expected in a data collection effort where response is mandatory. The response rate for the Generator Questionnaire was 88.0 percent, and the response rate for the Treatment, Storage and Disposal General Questionnaire was 90.5 percent. Response rates for the process-specific questionnaires ranged from a low of 81.1 percent for the Land Treatment Questionnaire to a high of 92.0 percent for the Container Questionnaire. Lists of nonrespondents were sent to the EPA regional offices for review and followup actions.

Further details regarding data collection techniques, return status frequencies, response rates and nonresponses may be found in Appendix B: Field Report.

2.5 Quality Control

Quality control efforts were focussed on two goals. The first goal was to obtain the highest possible level of statistical quality by achieving a high response rate. The second goal was to minimize nonsampling error to the greatest extent possible.

2.5.1 Response Rate Quality Control

In order to encourage a high response rate, the questionnaires were designed to be self-administered and easy to answer. In addition, the questionnaire mailout package included a general instruction booklet and other supplementary information. Technical assistance, in the form of telephone hotline information services, was offered to all respondents both by Westat and by the EPA RCRA hotline. Efforts to make the data collection instruments easy for respondents to answer were also intended to make it easy for respondents to answer accurately and consistently, thus minimizing nonsampling error as well.

Questionnaire packages were sent by certified mail, in order to provide proof of delivery. A small percentage of the certified mail cards were not returned, even though the questionnaire package itself had not been returned as undeliverable. The Post Office was requested to trace those missing certified packages and report back on the delivery status. Telephone directory searches and some phone calls were used to research new addresses for facilities/installations with inadequate addresses and for questionnaire packages that had been returned undelivered. Most of the facilities receiving Treatment, Storage and Disposal General Questionnaires and process specific technology questionnaires had been verified or updated through a telephone verification survey that preceded the mailout survey.[2]

A number of approaches were used to encourage the recipients of the questionnaire packages to complete and return them. The cover letter to the questionnaire package informed the recipients of their legal obligation to respond to the questionnaires. Nonrespondents who had not returned their questionnaires within the 45-day period permitted, received followup letters informing them of the lateness of their response. Generator installations that had not responded within 80 days of receiving the questionnaire package were sent a second followup letter. TSD facilities not responding after 80 days were followed up by telephone.

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[2] The telephone verification survey is described in detail in the "Report on the Telephone Verification Survey of Hazardous Waste Treatment, Storage and Disposal Facilities Regulated Under RCRA in 1981," produced by Westat in November 1982.

2.5.2 Nonsampling Error Quality Control

Efforts to minimize nonsampling error focussed on respondent error (which included inconsistent as well as missing responses), and processing error (which included coding error, data entry error, and programming error).[3] Editing for these types of error occurred at virtually all stages of survey processing. Coders were trained to edit for missing and inconsistent responses while coding. Coders' work was 100 percent sight verified ("proofed") by trained coder verifiers, who were also assigned to check for respondent errors. After data entry, all data files were "machine edited" using computer programs that checked the valid range of each data item and performed logical consistency checks among data items. Coding supervisors reviewed the frequency distributions for all data items, looking for errors that the computer machine edit program had not found. Analysts reviewed complex logical comparisons within each data file.

Some respondent errors involving incomplete responses and inconsistent responses could not be resolved without recontacting the respondent. The process of recontact is called "data retrieval." For this study, data retrieval generally required telephone recontact of the respondent. About 30 percent of the Treatment, Storage and Disposal General Questionnaire respondents were recontacted during data retrieval, and about 10 percent of the Generator Questionnaire respondents were recontacted. In addition, a rigorous effort was made by survey analysts to recontact the TSD facilities that managed the largest quantities of hazardous waste by each of the management technologies. A separate report on this editing effort is presented in Section 2.5.3, following.

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[3] The concept of nonsampling error is further expanded upon in Section 3.1.

2.5.3 Editing of Large Quantity Cases in the Component Data Files

In addition to the editing procedures described in Section 2.5.2, the largest quantities in each of the processes reported in the component questionnaires received special edit consideration. First, facilities were ranked according to their weighted quantities for each component process. Professional staff then checked questionnaires of the largest facilities for internal consistency. Component information reported in the TSD General Questionnaire provided the primary consistency check, but component questionnaires of other processes were also used for facilities belonging to the sample frame of more than one process.

Particular attention was given to known problem areas such as misreporting exempted wastewater streams, misreporting measurement units, or defining "hazardous" incorrectly.

The number of top facilities examined varied with each process type, but generally included:[4]

- At least the top five facilities in each sample;
- At least 50 percent of the total weighted quantity; and
- All sampled facilities representing at least five percent of the total weighted quantity.

Fortunately, a large part of the quantity managed by each hazardous waste treatment, storage or disposal process was represented by a small number of facilities in the sample. This is most dramatically illustrated in disposal surface impoundments where the largest facility in the sample accounted for 93 percent of all surface impoundment disposal quantities. The process showing the least skewed distribution of quantities was the injection wells' disposal process. Even so, more than 50 percent of the total quantity was accounted for by only 8 of the 73 respondent injection well facilities. Table 1 presents the exact quantity coverage of this editing procedure for each component.

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[4] Waste pile quantities could not be examined because the component questionnaire did not contain a general quantity question. Only 38 percent of the (weighted) incinerated quantity was edited.

2.6 Imputation Procedures Used for Quantity Estimates

In order to present quantity estimates representing the entire population of hazardous waste facilities regulated by RCRA, quantity data presented in this report include imputed values. If a facility reported "don't know" instead of a quantity, the mean value of applicable cases was imputed for that facility. This is also true for facilities where the quantity was "not ascertained," or where at least one element determining the quantity was unknown.

The quantity totals are always equal to the known number of facilities times the mean quantity of applicable facilities with known values. This insures that the entire population is represented by the quantity estimate.

Table 1. Special Edit Coverage of the Largest Facilities in Each Component Data File

Process	Percentage of Total Weighted Quantity Represented		
	Rankings of Edited Facilities	Largest Unedited Facility	All Edited Facilities
Treatment			
Tanks	1-5	< 5%	72%
Surface impoundments	1-8	< 4%	66%
Incinerators	1-8	< 2%	38%
Storage			
Tanks	1-5	< 2%**	76%**
Containers	1-6	< 4%**	52%**
Surface impoundments	1-7	< 4%	77%
Waste piles	*	*	*
Disposal			
Injection wells	1-8	< 4%	51%
Landfills	1-5	< 3%	68%
Surface impoundments	1-5	< 1%	90%
Land applications	1-9	< 5%	72%

*Waste pile questionnaires did not have a measure of quantity, but the three largest potential quantities were edited.

**Percentages are based on the weighted quantities of waste that entered storage in 1981.

NOTE: The terms "edited" and "unedited" in this table refer to the special edit described in Section 2.5.3. All questionnaires returned during the survey were processed through standard manual and machine-assisted editing systems.

3. STATISTICAL RELIABILITY AND DATA ACCURACY

3.1 The Concepts of Sampling Error and Nonsampling Error

A variety of estimates are presented in this report providing measures for characteristics of interest. These include estimates of the percentage (or number) of sites with a particular characteristic and total quantities of hazardous waste in various contexts. It is important to keep in mind that these are survey estimates and are subject to errors of various kinds. Such errors can be classified into two general categories: sampling error and nonsampling error.

A measurement of sampling error is an assessment of the precision of estimates obtained from a sample, as opposed to a census, of a population. A census -- where all sites would be selected to be respondents -- has no sampling error associated with it. Differences between measures obtained from a census and the "true" values for the population cannot be attributed to having taken only a sample or subset of the population as respondents. An estimate from a sample will usually differ from the "true" population measure, and the extent to which this is attributable to the variability inherent in selecting a sample can be measured. Confidence intervals and standard errors (standard deviations of an estimate) are measures of sampling variability or sampling error. If the sampling error is relatively small, the sample estimate is likely to be close to the "true" population measure, assuming that the effect of nonsampling error on the estimates is minimal.

Nonsampling error refers to all other sources of error that might occur in a survey. These include mistakes in entering

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values on a questionnaire, misinterpretation of questions, undetected data entry errors, transcription errors, nonresponse, etc. A census, as well as a sample, is susceptible to nonsampling errors. In general, nonsampling errors cannot be measured from the data collected in a survey. Nevertheless, for this survey, efforts have been made to assess the possible impact of such errors. In cases where there is a possibility that nonsampling errors may have an important effect on the estimates, this is noted in the report.

3.2 Response Rates and Sample Sizes

A major reason to maximize the number of respondents providing data in a survey is that one can never be sure that nonrespondents have the same characteristics as respondents. To the extent that nonrespondents are different from respondents, survey estimates, based solely on respondents, are to some degree biased. Response rates obtained for this survey were exceptionally high for a mail survey, due in part to the mandatory response authorities under which the survey was conducted. Table 2 presents the number of questionnaires mailed out, the number received, and the number of eligible respondents for each questionnaire type. It should be noted that the number of TSD General Questionnaires mailed out cannot be obtained by summing across the number mailed out for the individual components. This is true for two reasons. First, a TSD facility may have received questionnaires for more than one process type. Second, generators associated with on-site TSD facilities on the sampling frame also received TSD General Questionnaires. Also, note that the sum of the number of eligible storage tanks and treatment tanks (233 + 121 = 354) exceeds the number of eligible respondents to the Tank Questionnaire (283) because some respondents used both process

Table 2. Number of Eligible Responses and Response Rates to the RCRA Survey

		Responses		
Questionnaire Type 1	Questionnaires Mailed Out 2	Total Received 3	#Eligible on Data File 4	Response Rate (Col.3÷Col.2) 5
Generators	11,220	9,877	2,084	88%
From Notifier File	10,667	9,361	1,710	88%
From Part A/ Telephone Verification File	553	516	374	93%
TSD's (General Questionnaire)	2,599	2,348	1,462	90%
[TSD Components]				
Injection Well	115	103	73	90%
Landfill	202	172	79	85%
Land Treatment	122	99	37	81%
Surface Impoundment	327	298	145	91%
Waste Pile	243	215	73	88%
Incinerator	265	239	125*	90%
Storage Container	423	389	191	92%
Tank	847	772	283	91%
Storage			233	
Treatment			121	

*117 of the eligible incinerator respondents represent facilities with active incinerators in 1981. The remaining eight eligible incinerator respondents had hazardous waste incinerators that were temporarily shut down or under construction during 1981 but were defined as eligible because the incinerator questionnaire was designed to obtain additional information concerning incinerators in these categories.

types. "Ineligible" respondents are those respondents that did not generate regulated quantities (generators that produce less than 1,000 kilograms of hazardous waste or less than 1 kilogram of acutely hazardous waste during 1981 are examples of "ineligible" generators) or that did not actively manage hazardous wastes in processes regulated under RCRA during 1981 (exempted wastewater treatment tanks under NPDES or RCRA-regulated landfills into which hazardous wastes were not disposed during 1981 are examples of "ineligible" facilities or processes).

Column 5 of Table 2 presents the response rates obtained for each questionnaire component. Please note that compliance with the survey was mandatory under authority delegated to EPA in Section 3007 of RCRA. Response rate is defined as the percentage of responding facilities among all facilities sent a particular questionnaire (Column 3 divided by Column 2 in Table 2). As shown in Column 5, the response rates fell in the vicinity of 90 percent for most process types. With response rates this high, there is generally little need for concern about nonresponse bias unless an extremely large handler fails to respond, but the extent of such occurrences among the nonrespondents to this survey is unknown. It is known, however, that certain item nonresponses (failure by a respondent to answer a particular question) involved very large facilities and may therefore subject certain items to nonresponse bias.

3.3 Statistical Reliability and Sampling Error

The statistical precision achieved in the survey depended on the type of questionnaire (individual process type, TSD general, or generator) and the type of estimate (characteristic percentages or quantities). The sample and universe sizes varied by questionnaire type. For the Tank, TSD General, and Generator Questionnaires, eligible sites on the sample frame were assigned varying probabilities of selection depending on what process types were indicated as being on site according to the information on the sample frame and, for generators, depending upon their Standard Industrial Classification code (see Appendix A, Section A.1, for more details on SIC code stratification). Each of these situations contributed to varying levels of precision for the questionnaire types.

More importantly, the sample was designed to be more efficient for estimates of facility characteristics (e.g., the percentage of landfills that have liners) rather than quantities (e.g., the quantity of hazardous waste generated). As explained in Section 2.3, this type of sample design (equal probability of selection for all components except tanks, generators, and the TSD General Questionnaire) was chosen partly due to the importance of determining facility characteristics and partly due to the absence of reliable facility size information at the time the sample was drawn. Without adequate size information, it is not possible to make an effective probability proportional to size (PPS) sample selection.[1] (Section 2.3 discusses the issues of the sample design in more depth.)

As a result, quantity estimates (or ratios of quantity estimates) are subject to considerably more estimation error than are estimates about the number or percentage of sites with certain characteristics. A high degree of precision was achieved for these estimates of site characteristics. For example, the precision achieved at the 95 percent confidence level for estimated percentages from the TSD General Questionnaire was 3.0 percent. This indicates that one can be "95 percent confident" that the true percentage is within ± 3.0 percent of the estimate.

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[1] By "facility size" we mean a measure of the quantity of hazardous waste managed or generated at the facility.

As the quantities of hazardous waste generated or managed vary dramatically among facilities, the precision of the survey's quantity estimates is much lower. To illustrate the large variation that occurs in facility size, consider Figure 3. The percentage of the TSD facility population managing at least a given quantity of hazardous waste is presented for several different percentages. For example, an estimated one percent of the TSD facility population each managed at least 306 million gallons of hazardous waste, while an estimated 5 percent each managed at least 24 million gallons. Clearly, the size distribution of facilities is skewed, due to the existence of some very large hazardous waste management facilities. The resulting mean value is 195 times the median. Figure 4 is an alternative way of looking at the population distribution of hazardous waste TSD facilities. From Figure 4 we see that if all hazardous waste facilities were ranked from the largest to the smallest, then a mere one percent of the facilities would account for more than 70 percent of the hazardous waste managed. In fact, sites representing the largest 240 (5%) TSD facilities were associated with 67.7 billion gallons of managed hazardous waste in 1981, accounting for 95 percent of the 71.3 billion gallons estimated to have been managed by all 4,818 TSD facilities in 1981. To confirm the quantities reported by the largest facilities, EPA made independent verification telephone calls to the largest cases and also determined through in-depth discussions that the wastes and processes reported were indeed RCRA-regulated.

Figure 3

DISTRIBUTION OF MANAGEMENT FACILITY SIZE (quantity managed)

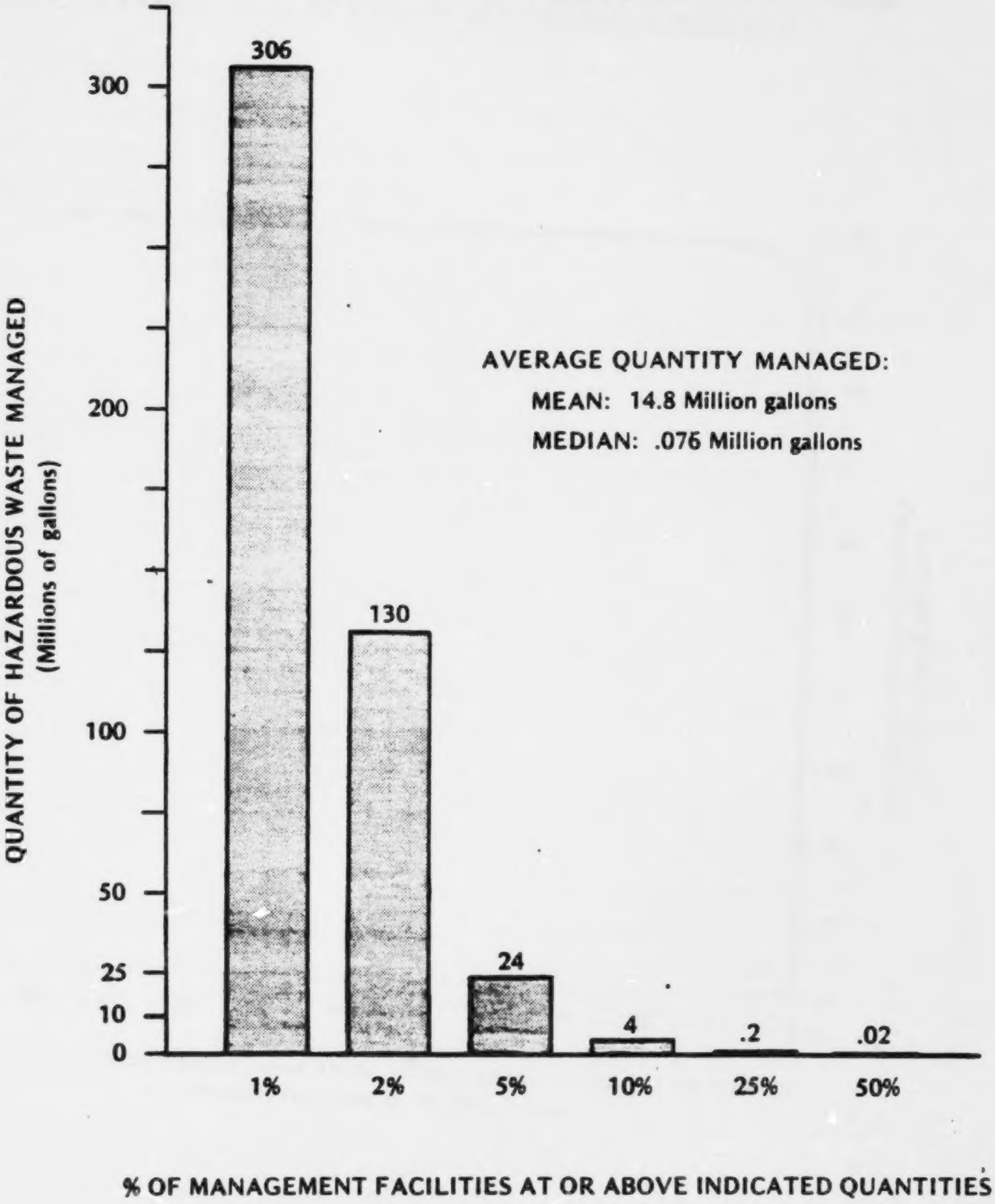
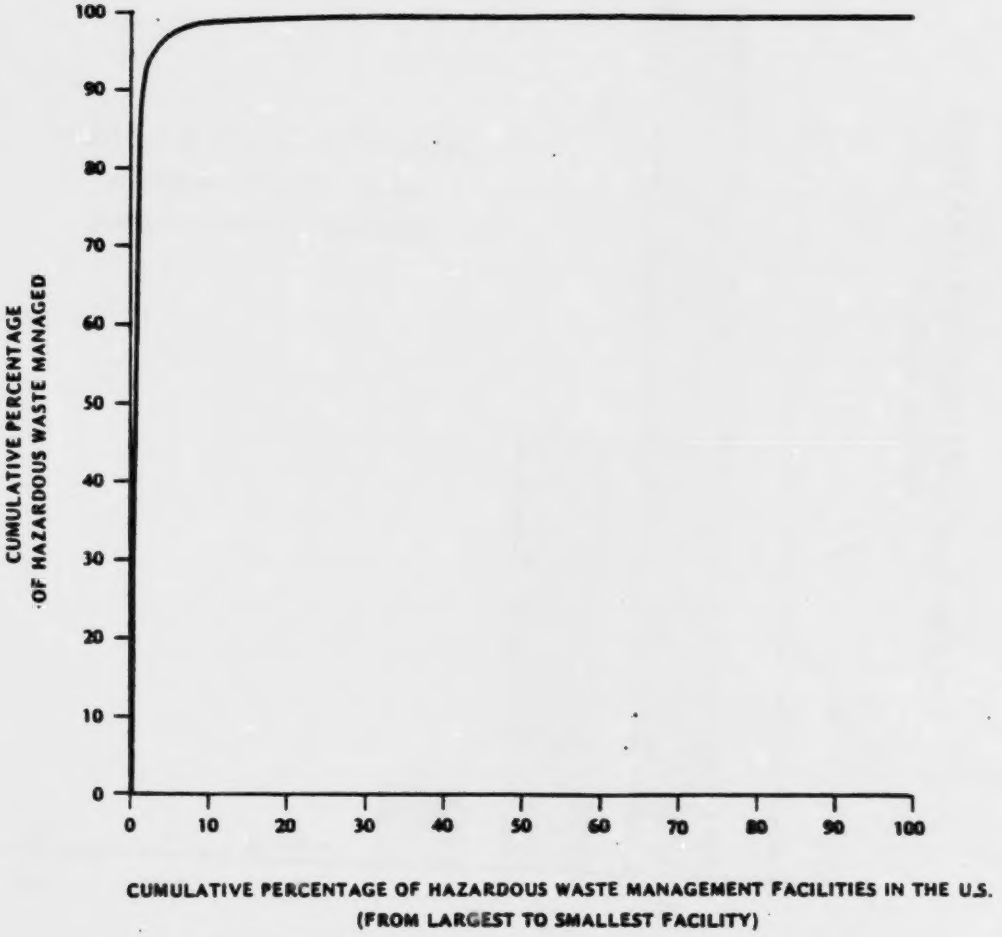


Figure 4

COMPARISON OF CUMULATIVE DISTRIBUTIONS OF QUANTITY OF HAZARDOUS WASTI MANAGED IN 1981 AND THE NUMBER OF MANAGEMENT FACILITIES



Similarly skewed distributions were found for hazardous waste generators according to responses to the Generator Questionnaire that were also verified by telephone for large facilities. Furthermore, since most hazardous waste is generated by facilities that manage their waste on site, the skewed distribution of generators could also be observed by examining the quantities generated at management facilities, according to responses to the TSD General Questionnaire. In fact, this method of estimating generation proved to be statistically more reliable than estimates of the same population from the Generator Questionnaire. As a result, generation data from the TSD General Questionnaire were combined with data on generators without management facilities from the Generator Survey to form the generation estimate that is used in this report.[2] Despite this improvement, the skewed distribution still led to an imprecise estimate.

Table 3 provides a comparison of the low degree of precision achieved for three quantity estimates: 1) the survey's preliminary estimate of the total quantity of hazardous waste generated as derived from the Generator Questionnaire; 2) the total quantity of waste that was managed as hazardous waste as derived from the TSD General Questionnaire, and 3) the survey's final estimate of the total quantity of hazardous waste generated which, as is explained in greater detail below and in Section 6.1, is derived through a combination of data obtained through the Generator and TSD General Questionnaires. The quantity estimates contrasted are then with the high degree of precision achieved for estimated percentages of generator installations and TSD facilities based on all respondents to the questionnaire.

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[2] The generation estimate and methodology used to derive it are detailed in Section 6.1.

Table 3. Statistical Reliability of Estimates from the Generator and TSD General Questionnaire

Questionnaire	95% Confidence Interval on an Estimated Percentage	95% Confidence Interval on an Estimated Quantity of Hazardous Waste Generated (or Managed)
Generator	± 2.4%	± 79.7% of the tota
TSD General	± 3.0%	(± 48.8% of the total)
Combination of Generator and TSD General Used Only to Derive 1981 Generation Estimate	Not applicable	± 49.7% of the tota

To interpret the plus or minus factor indicated in the table for an estimated quantity of hazardous waste generated (or managed), the true value of the total quantity of hazardous waste generated (or managed) is covered with 95 percent confidence by an interval centered at the estimated value and extending on either side of the estimated value. For example, if the TSD general estimated quantity were 100 million gallons, the corresponding 95 percent confidence interval would extend from 51.2 million gallons to 148.8 million gallons. Clearly, the confidence interval is quite wide, and the estimated quantity of total hazardous waste managed is not very precise. A similar interpretation holds for the ±49.7 and ±79.7 percent factors for the two estimates of the quantity of total hazardous waste generated, which are even less precise.

To interpret the plus or minus factor indicated in the table for an "estimated percentage of facilities" estimate for generators, the true value of the percentage of installations with a particular characteristic is covered with 95 percent confidence by an interval centered at the estimated percent and extended on either side of the estimate by the percentage shown below. For example, a conservative 95 percent confidence interval for an estimate of 40 percent of the TSD facilities having a particular characteristic (e.g., they receive waste from off site), would extend from 37 percent to 43 percent of all TSD facilities (40% ±3.0%). It should be noted that these "plus or minus" terms are established using an estimate of 50 percent (a proportion of .5).[3] Such intervals provide at least 95 percent confidence. A conservative approach was selected since these limits may be applied as a tool to assess the general precision of estimated percentages. If more specific limits for particular items are desired, these need to be individually computed.

Sampling errors for quantity estimates other than those presented in Table 3 generally indicate less variability than the ±79.7 percent confidence interval for the Generator Questionnaire estimate of hazardous waste generated. The Generator Questionnaire estimate of hazardous waste generated and shipped off site, for example, has a ±30 percent confidence interval at the 95 percent level. The estimated quantity generated but not shipped off site, on the other hand, has a confidence interval that exceeds ±79.7 percent because of the great variability of quantities generated by the generators sampled from this population. This led to concern about the accuracy of Generator Questionnaire estimates of the quantity generated on site by this part of the generator population.

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[3] The confidence interval for other proportions would be smaller if individually computed. A quick approximation can be obtained by multiplying the conservative interval shown in Table 3 by $2\sqrt{(p)(1-p)}$ where "p" is the proportion. Examples are provided later in Section 4.1 and 5.1 footnotes.

Fortunately, a second, less variable data source, the TSD General Questionnaire, could be used to estimate the quantity generated for these generators that also managed waste on site. This led to the previously mentioned combined generation estimate based on responses to the Generator Questionnaire from generators without management facilities, and responses to the TSD General Questionnaire from generators with management facilities, yielding an overall interval for the 1981 generation estimate of ±49.7 percent at the 95 percent confidence level. Because this was considerably lower than the ±79.7 percent confidence level from the Generation Survey estimate, and for other reasons cited in Section 6.1, the combined survey estimate served as the source of the final 1981 generation estimate presented in this report.

For individual components or process types, the accuracy on percentages of facilities with particular characteristics ranged from ±5 to ±11 percent, as shown in Table 4, but was better than ±10 percent for all components except Land Treatment. These confidence intervals were based on the number of facilities responding to each of the process type (component) questionnaires, and the size of the universe. They are also based on the conservative assumption that the estimated proportion of the characteristic of interest (e.g., line their landfills), is .50 (i.e., 50 percent). As previously footnoted, the confidence intervals for other proportions can be determined by multiplying the conservative interval shown in Table 4 by $2\sqrt{(p)(1-p)}$, where "p" is the proportion expressed as a decimal.

Table 4. Number of Respondents and Statistical Reliability of Estimated Percentages, by Process Type

Process Type	Number of Respondents Active in 1981	95 Percent Confidence Interval on an Estimated Percentage of Facilities
Injection Wells	73	± 4.8%
Landfills	79	± 8.7%
Land Treatment	37	± 11.3%
Surface Impoundment	145	± 7.5%
Waste Piles	73	± 8.9%
Incinerators	117*	± 6.6%
Storage Containers	191	± 7.2%
Storage Tanks	233	± 6.4%
Treatment Tanks	121	± 8.6%

*The sample size for incinerators is 125, when one includes eight eligible respondents to the questionnaire component who were not active in 1981. (See note to Table 2).

The 95 percent confidence intervals presented in Tables 3 and 4 are based on questions that required an answer from all respondents to the questionnaire. If it is desired to approximate 95 percent confidence intervals on the estimated percentage of sites with a particular characteristic for subsets of the respondents (e.g., landfills with liners), the "plus" or "minus" term shown for the 95 percent confidence interval should be multiplied by the factor, K, shown below in Table 5.

Table 5. "K" Factors to Be Used in Obtaining 95 Percent Confidence Intervals for Population Subsets

Subpopulation as a fraction of the population	Factor, K, to multiply term in Tables 3 or 4
.80	1.1
.60	1.3
.40	1.6
.20	2.2
.10	3.2

The "K" values presented above are reasonable approximations as long as the subsample size is fairly large, say 30 or more, and the estimated percentage is not extremely large or extremely small.[4] Also, the use of "K factors" for approximating confidence intervals around quantity estimates is only appropriate if the subpopulation has approximately the same distribution as the population as a whole. If regional distributions of waste quantities were similar, for example, the "K factor" could be used to approximate the 95 percent confidence intervals around the regional quantity estimates. Waste group quantities, however, are likely to have very different distributions among waste groups, and the "K factors" would not be appropriate for approximatin confidence intervals.

An example of how to obtain an estimate of variability (i.e., the confidence interval) for a subgroup of a population applying the "K factor" to an estimate of the whole population (based on all respondents) is as follows: Table 3 shows that percentage estimates for generators are accurate to ± 2.4 percent at the 95 percent confidence level. However, the subpopulation of "generators" that managed all of their waste on site" is only 16 percent of all generators (based on 338 respondents, so the concern about small sample sizes is satisfied and use of the K factor is appropriate). Therefore using the formula $K = \sqrt{N/n}$ (see footnote 2), $K = \sqrt{1/.16} = 2.5$. Thus, the accuracy for this subpopulation of generator is:[5]

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[4] "K factors," besides those shown in Table 5, can be calculated from the population estimate (N) and the sample size (n) using the formula $\sqrt{N/n}$ where n times the lesser of n/N or 1-(n/N) is greater than or equal to 15. (This is only an approximation where weights are not uniform.)

$$(2.5)\ (\pm\ 2.4\%) = \pm\ 6.0\%.$$

3.4 Nonsampling Error

As indicated earlier, nonsampling errors are those which result from sources other than that attributable to sampling. There were various potential sources of nonsampling errors in these surveys. Although such errors are generally not quantifiable, it is important to acknowledge these sources so that users of the survey data may be aware of their possible effects.

Potential sources of nonsampling errors include: nonresponse bias (discussed in Section 3.2); the misinterpretation of questions; mistaken responses to questions; inadequate definitions of terms or inappropriate assumptions inherent in the questions; rounding errors; and errors in converting from wet to dry measures (e.g., from gallons to metric tons) because the generally assumed relationship between wet and dry measures does not hold in a particular case (e.g., the specific gravity of the liquid differs considerably from the assumed specific gravity).

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[5] It should be noted that for items from the Generator, Tank and TSD General Questionnaires, the K values in Table 5, or those based on the above formula, represent approximations. This is due to the fact that sites selected for the generator, tank, and TSD general samples were selected with variable sampling rates, resulting in nonuniform weights.

All of these errors probably occurred to a limited extent. There is no evidence to suggest that they introduced an inordinate amount of bias/error into the survey results, with the possible exception of nonsampling errors related to the proper inclusion/exclusion of hazardous wastewaters and other waste in mixtures. It is possible that up to 5 billion gallons of hazardous waste in wastewaters that were treated exclusively in RCRA-exempt NPDES tanks could not be eliminated by the TSD General Survey's editing procedures, and as such may be erroneously included in the TSD General Survey's quantities treated and managed. There was also evidence that a substantial quantity of hazardous wastewater mixture went unreported as only the dry weight of hazardous materials was reported. The potential impacts of such possible errors are discussed in more detail in the appropriate quantity sections of this report.

PART II (Sections 4–5)

NUMBERS OF GENERATORS

AND

MANAGEMENT FACILITIES

INTRODUCTION TO PART II:

NUMBERS OF HAZARDOUS WASTE GENERATORS AND MANAGEMENT FACILITIES

This part is made up of two major sections. Section 4 and its subsections describe the number of hazardous waste generators and various subpopulations of these generators. Section 5 and its subsections describe the number of management facilities that treat, store, or dispose of hazardous waste.

As previously stated, the statistical reliability of data from this survey related to the number of facilities is generally very good. It is especially good for generators, owing mainly to the large sample (2,084) in the Generator Survey. For generators as a whole, the 95 percent confidence interval on a proportion of installations is ± 2.4 percent. For management facilities it is ± 3.0 percent. Estimates for subpopulations have wider confidence intervals, becoming less precise as the subpopulation gets smaller. For a more detailed explanation of the issue of precision, please refer to Sections 3.3 and 3.4.

4. NUMBER OF HAZARDOUS WASTE GENERATORS

Sections 4.1 through 4.5 define hazardous waste generators and describe their population in terms of the number of facilities in each EPA region, the industries to which they belong, the hazardous waste groups they generate, whether or not they ship some or all of their generated hazardous waste off site, and how many recycle part of their hazardous waste.

A generator is defined in 40 CFR §260.10 as "any person, by site, whose act or process produces hazardous waste identified or listed in Part 261 of this chapter or whose act first causes a hazardous waste to become subject to regulation." Among wastes specifically excluded in Part 261 are:

- Wastes that pass through a sewer system to a publicly owned treatment plant;
- NPDES permitted point source discharges of industrial wastewater regulated under Section 402 of the Clean Water Act, as amended;
- Certain trivalent chromium wastes, including chrome trimmings and shavings, buffing dust, sewer screenings and wastewater treatment sludges generated by various subcategories of the leather tanning and finishing industry, that fail the EP toxicity test for chromium, but do not fail any other EP toxicity tests and do not fail the tests for any other characteristics;
- Irrigation return flows;
- Solid agricultural wastes returned to the soils as fertilizer (such as crop residuals or manure);
- Household wastes or materials derived from household wastes (e.g., refuse-derived fuel);
- Source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.;

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- In situ mining wastes that are not removed from the ground as part of the extraction process;
- Solid waste from extraction, beneficiation and processing of ores and minerals, including coal;
- Mining overburden returned to the mine site;
- Drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil, natural gas or geothermal energy;
- Fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste generated primarily from fossil fuel combustion;
- Wastes produced by small quantity generators (generators generating less than 1,000 kilograms in a month) where no more than 1 kilogram per month of acutely hazardous waste is produced; and
- Certain recycled wastes (that is, wastes that are being beneficially used or reused, or legitimately recycled or reclaimed).

As of October 13, 1983, there were 51,345 establishments on EPA's Notifier file indicating current, or possible future, generation of nonexempt hazardous waste. In mid-1981, the year of the survey data, nearly 60,000 such notifiers were listed in EPA's files. The reduction between 1981 and 1983 occurred as a result of EPA's effort to remove "protective notifiers" and other nonregulated notifiers from its files. Greater elaboration of this issue is provided in subsequent pages of this section.

The survey sample was drawn from an August 1, 1982 list of 55,739 notifiers. Based upon responses to the survey, EPA now estimates that about one-quarter of these establishments actually generated RCRA-regulated quantities of hazardous waste during 1981. EPA estimates that there were 14,098 active generators of hazardous waste regulated under RCRA in 1981 (see Figure 5), with the remaining 41,641 of the 55,739 notifiers in that year falling into the various categories presented in Table 6.

Table 6. Characteristics of Nonregulated Notifiers that Responded to the Survey

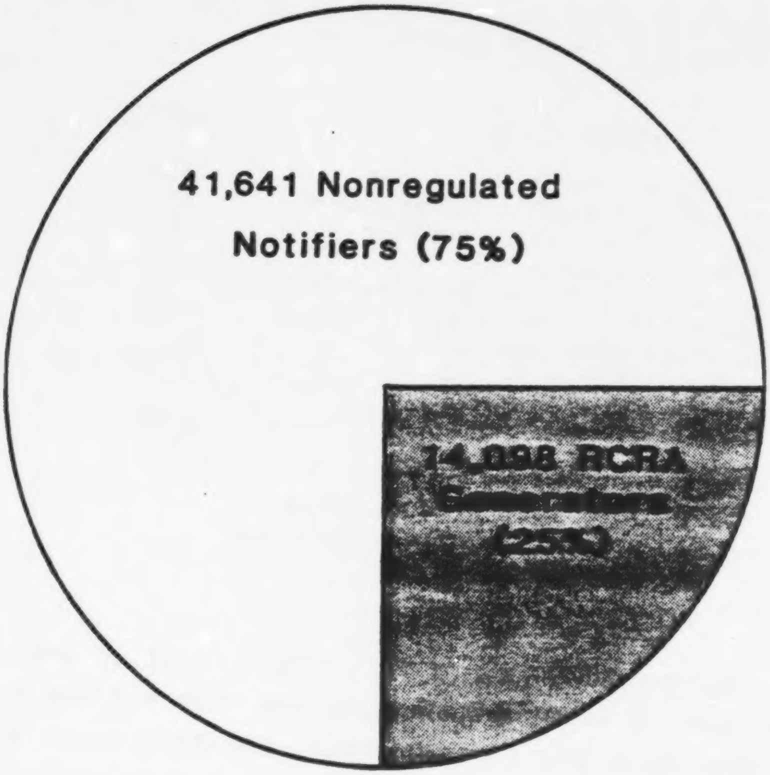
Description	Percent
Non-generators	43%
Potential Future Generators	18%
Small Quantity Generators	18%
100% Recyclers	4%
Recently Retired Generators	3%
Delisted Waste Generators	1%
Nonregulated Notifiers NSK, NEC*	13%
Total	100%

*NSK = not specified by kind
NEC = not elsewhere classified

Nonregulated Notifiers - Nearly half of the nonregulated notifiers sampled from the notifier and Part A files did not generate hazardous waste during 1981, the five years preceding 1981, nor did they expect to generate hazardous waste in the five years following 1981. This overfiling may have been done for protective reasons to ensure compliance with RCRA regulations, for contingency planning, or because respondents misinterpreted the regulations. Eighteen percent of the nonregulated notifiers sampled had not generated hazardous waste during 1981, but expected to within the next five years.

Figure 5

PORTION OF NOTIFIERS THAT GENERATED RCRA–REGULATED QUANTITIES OF HAZARDOUS WASTE IN 1981



55,739 Notifiers

Source: HWDMS, 8-1-82

Generators of hazardous waste in 1981 that were exempt from RCRA as "small generators" because they generated no more than 1,000 kilograms of hazardous waste, and not more than one kilogram of acutely hazardous waste, during any month also accounted for 18 percent of the nonregulated notifiers sampled. Generators that recycled all their hazardous waste, generators that retired within the last five years, and those that generated delisted waste accounted for four percent, three percent, and one percent respectively. The remaining nonregulated notifiers (13%) included a small number of farm-exempt generators, but for the most part, reported they were not RCRA-regulated generators without further specifying their status.

In the sections that follow, we discuss the distribution of number of generators by region of the country, by industry group, and other breakdowns. It is important to note that very different distributions may be found for the quantity of waste generated, which is presented later in Section 6.

4.1 Regional Distribution of Generators

While the actual number of generators actively generating RCRA-regulated quantities of hazardous waste during 1981 is now estimated to be significantly lower than initially thought, the distribution of generators across EPA's ten regions remains similar to the distribution of Notification submissions. The regional distributions of two different notifier lists are compared, in terms of percentages, to the regional distribution estimated by the survey in Table 7. The 1981 survey sample frame was drawn from the August 1, 1982 list of notifiers. The most current EPA list of notifiers at the time this report was being written was as of October 13, 1983. Looking at the regions as three groups, those with the largest share of notifiers are estimated to have the largest share of active generators. The estimated number of hazardous waste generators in each region is presented in Figure 6.

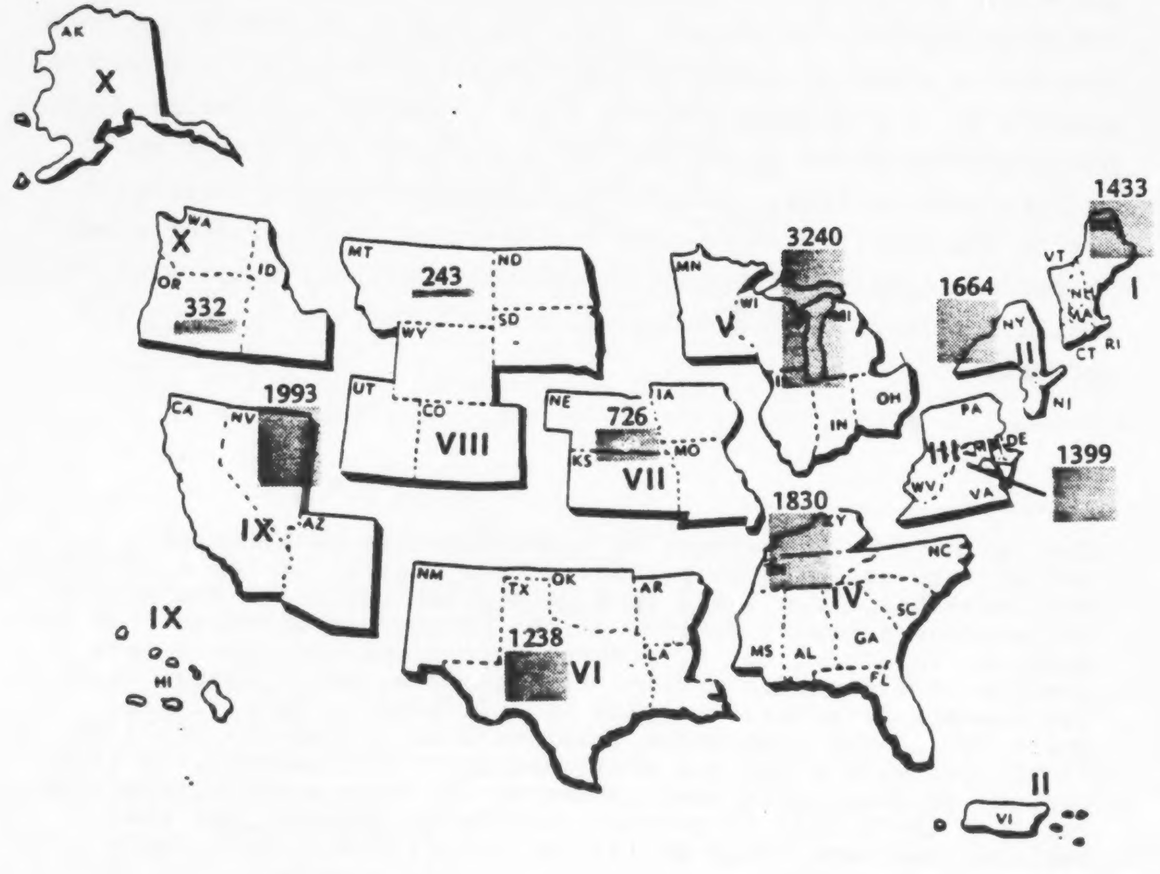
Table 7. Comparison of Notifier and Generator Distributions in EPA Regions

Rank	Region	Survey Estimated Percent of Generators 1981	Percent of Notifiers Identified on HWDMS File as of: 8/1/82	Percent of Notifiers Identified on HWDMS File as of: 10/13/83
1	V	23.0%	22.4%	21.6%
2	IX	14.1%	10.2%*	11.3%*
3	IV	13.0%	13.1%	12.8%
4	II	11.8%	12.4%	14.4%*
5	I	10.2%	8.0%	9.4%
6	III	9.9%	9.7%	10.4%
7	VI	8.8%	14.3%*	12.0%*
8	VII	5.1%	4.6%	3.3%
9	X	2.4%	3.1%	3.3%
10	VIII	1.7%	2.2%	1.5%
Total U.S.		100.0%	100.0%	100.0%

* These numbers are outside the conservatively stated range of the 95 percent confidence interval surrounding the survey estimates for those regions (i.e., the percent of generators ± 2.4%).

Figure 6

REGIONAL DISTRIBUTION OF HAZARDOUS WASTE GENERATORS IN 1981


AK
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IX
AZ
IX
HI
NE
IA
726
KS
MO
VII
NM
TX
OK
AR
1238
VI
LA
MN
WI
V
3240
MI
IL
IN
OH
1830
KY
IV
NC
SC
GA
MS
AL
FL
1664
NY
II
NJ
PA
III
MD
DE
WV
VA
1399
1433
VT
NH
MA
I
CT
RI
II
VI

ESTIMATED TOTAL NUMBER OF GENERATORS ACTIVE IN 1981: 14,098

Region V had 3,240 generators (or 23% of the U.S. total), decisively more than any other EPA region. Regions I-IV, VI and IX had between 1,200 and 2,000 generators apiece with Region VIII having the least (243).

The precision, at the 95 percent confidence level, of the survey estimates for the regional percentage of the national number of generators is conservatively stated as ± 2.4 percent for each regional estimate. Thus, for Region II, the 95 percent confidence interval around the estimate 11.8 percent is from 9.4 percent to 14.2 percent (11.8 ± 2.4).[1] However, estimates about the characteristics of facilities in a particular region would be less precise (i.e., would have larger confidence intervals), due to the smaller sample size for any given region. For example, 95 percent confidence limits on estimates of characteristics for facilities found within Region II would be approximately ± 7.0 percent.[2]

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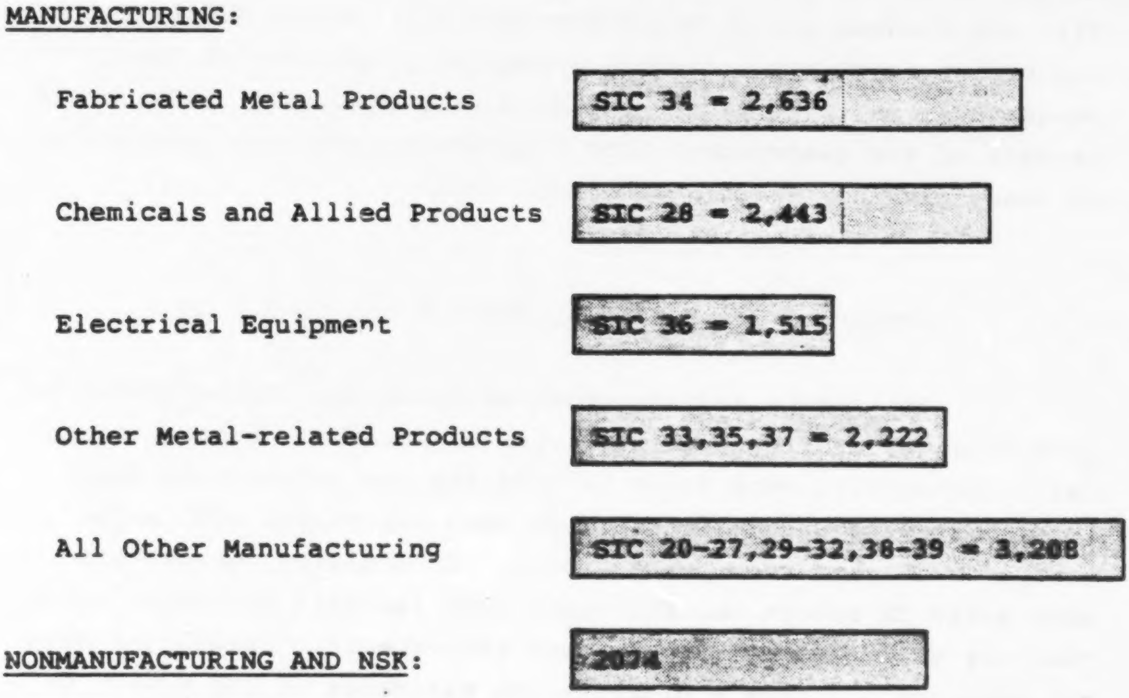
[1] The value of ± 2.4 percent is a conservative estimate of variability assuming 50 percent of the population has a particular characteristic (e.g., are in a particular region). The actual value grows somewhat smaller as the proportion diverges from 50 percent. To adjust for different proportions and obtain more precise confidence intervals, the conservative estimate (±2.4% for numbers of generators) can be multipled by $2\sqrt{(p)(1-p)}$, where "p" is the proportion (expressed as a fraction of 1) of facilities with a certain characteristic. For example, if 11.8 percent of generators were in Region II, then substituting .118 for "p," the actual 95 percent confidence interval for that regional estimate would be (±2.4%) (2) $\sqrt{(.118(1-.118)}$, or ± 1.5 percent. Therefore, we can be 95 percent confident that the percentage of generators in Region II is 11.8 percent ± 1.5 percent or in other words, between 10.3 percent and 13.3 percent. (Note that when p = .5, the confidence interval is ± 2.4%).

[2] Calculated with the "K factor" (see Table 5) as follows: $(2.4)\sqrt{1/p} = (2.4)\sqrt{1/.118} = \pm 7.0$.

4.2 Number of Generators by Industry Type

Hazardous waste generators were most prevalent in the manufacturing industries (SIC 20-39). Only 15 percent were nonmanufacturing generators, or unclassified. Industries manufacturing or processing metals, electrical equipment, or chemicals had the most generators as shown in Figure 7 below.

Figure 7. Number of Generators by Industry Type[3]



TOTAL GENERATORS = 14,098

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[3] Sampling error estimates were ±25 percent or less at the 95 percent confidence level. More detailed SIC breakdowns outside this range were not presented.

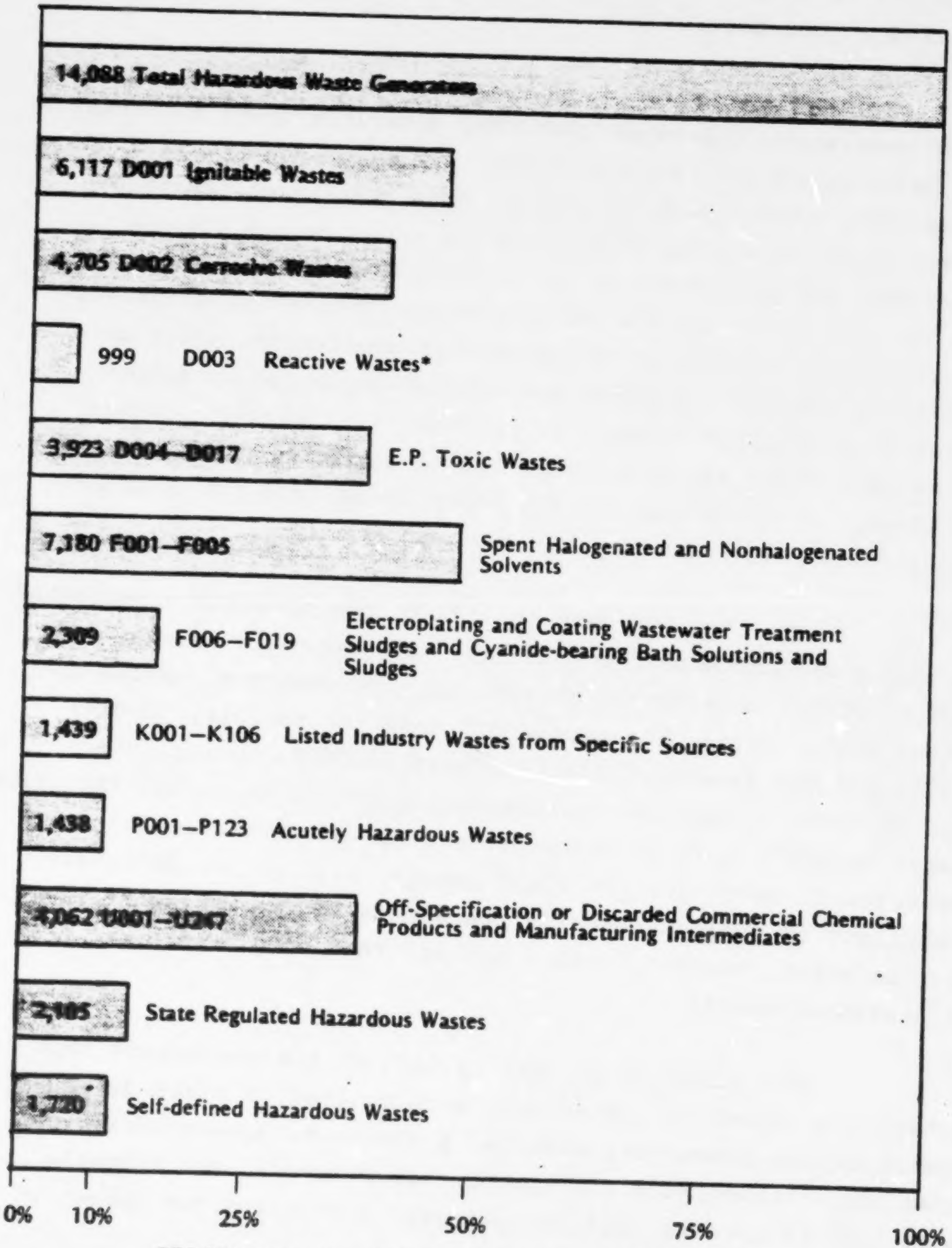
At the two-digit level, Major Group 34 of the Standard Industrial Classification Codes, SIC 34, Fabricated Metal Products, except Machinery and Transportation Equipment, had the most generators, about 2,600, or 19 percent of the total. The Chemicals and Allied Products industry (SIC 28) was ranked second with about 2,400, or 17 percent of the generators. Next, Electrical and Electronic Machinery, Equipment and Supplies (SIC 36) had about 1,500, or 11 percent of the generators. Metal-related manufacturing industries, not mentioned above, had about 2,200, or 16 percent of the generators. These included Primary Metal Industries (SIC 33), Machinery, except Electrical (SIC 35), and Transportation Equipment (SIC 37). Other manufacturing industries accounted for about 3,200, or 22 percent of the generators. As previously mentioned, the remaining 2,100, or 15 percent of the generators, were from nonmanufacturing industries, or industries not specified by kind (NSK).

4.3 Number of Generators by Waste Group Generated

The survey results provided estimates of the number of generators generating specific types of hazardous wastes during 1981. Generators were asked to indicate the portions of their total hazardous waste streams that were associated with major groups of EPA hazardous waste codes. In addition, generators were asked to report the EPA waste code for each hazardous waste that was generated, although waste code-specific quantities were not obtained. Figure 8 presents the estimates of the number of generators in major EPA hazardous waste groups, developed from a combination of the data provided by respondents to these two questions. Note that a given generator may have generated more than one type of waste, and that a given waste stream may have been reported under more than one waste code (multiple characteristic waste streams or mixtures). As a result, the sum of the generators

Figure 8

NUMBER OF ESTABLISHMENTS GENERATING EACH MAJOR WASTE GROUP



*Confidence Interval exceeds ± 25% at the 95% Confidence Level across all of these waste groups substantially exceeds the total of 14,098 in the population.

Just over half (7,180) of the total population of 14,098 generators indicated that they generated spent solvents, both halogenated and nonhalogenated (EPA waste codes F001-F005), during 1981. Generators of sludges from wastewater treatment systems associated with electroplating and aluminum coating operations and generators of cyanide-bearing quenching and plating bath solutions and their sludges (F006-F019) accounted for 16 percent (2,309) of the generator population, while only 10 percent (1,439) of the generators generated listed hazardous wastes from specific industrial sources, such as spent pickle liquor from steel finishing operations, pink/red water from TNT operations, or dissolved air flotation float from the petroleum refining industry ("K" prefix hazardous wastes).

Forty-three percent (6,117) of the generators generated ignitable wastes (D001), a third (4,705) generated corrosive wastes (D002), more than a quarter (3,923) generated wastes that failed EPA's "extraction procedure" test for toxicity (D004-D017), and 999 generated reactive wastes (D003) during 1981. Each of these categories includes wastes that, while not specifically listed in EPA's list of hazardous wastes, exhibit hazardous characteristics (e.g., low flash points, high or low pH levels, volitility or violent reactive tendencies with other substances such as water, toxicity, etc.) and are thus regulated under RCRA as hazardous wastes.

Just under 30 percent (4,062) of the generators reported generating hazardous wastes that were spilled, discarded, or off-specification commercial chemical products or manufacturing chemical intermediates ("U" prefix waste codes), and slightly more than 10 percent (1,418) indicated generating the subset of such products or intermediates that are regulated under RCRA as acutely hazardous wastes ("P" prefix waste codes, subject to a small generator exclusion level of only 1 kilogram per month).

In addition to the above EPA classications, more than 2,000 establishments generated wastes identified as hazardous wastes by states, but not by EPA, and another 1,700 handled wastes as hazardous wastes, even though they were not listed or identified as hazardous wastes by EPA or their state.

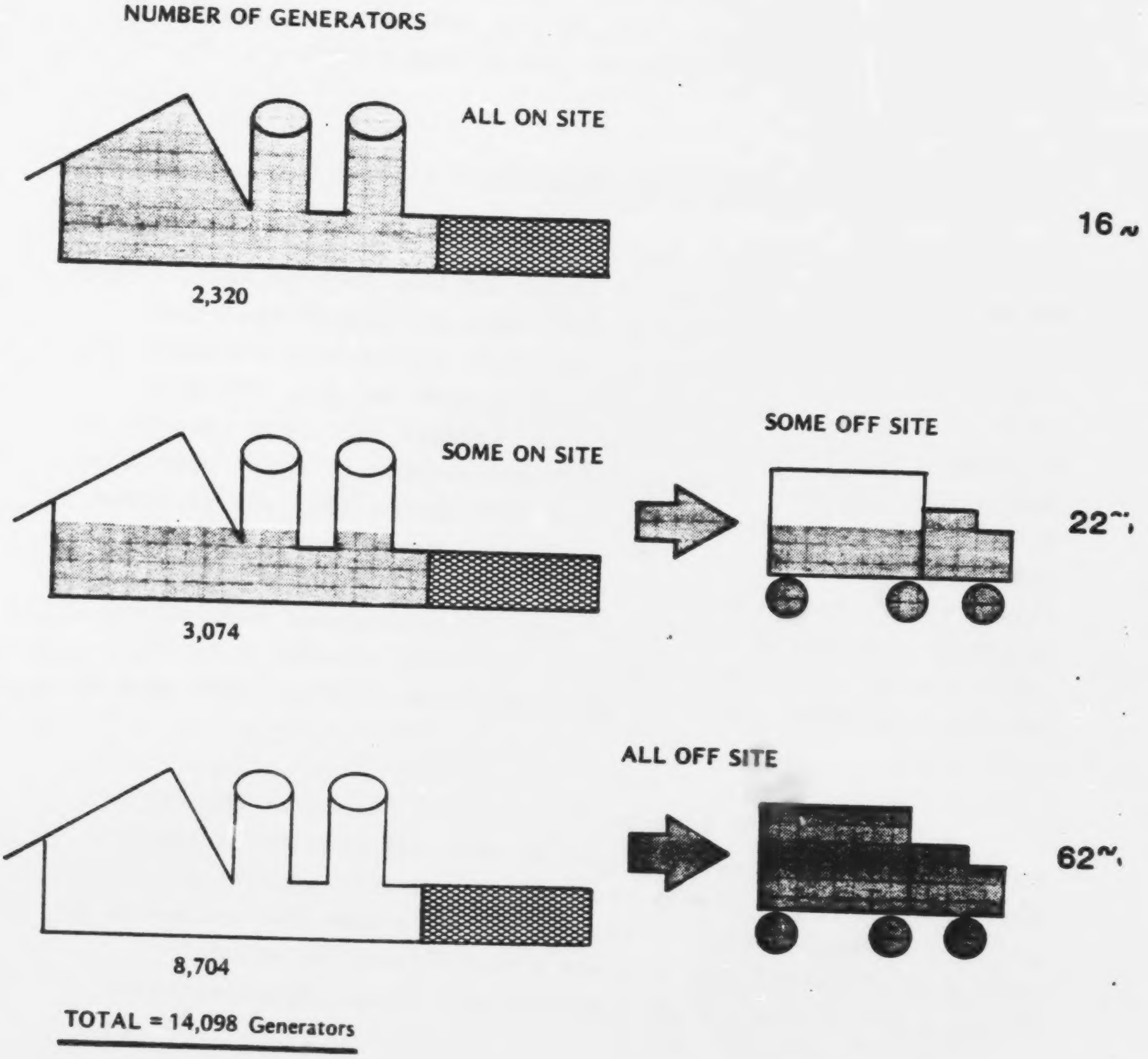
4.4 Number of Generators Shipping Hazardous Waste Off Site

Although nearly all hazardous waste is managed to some degree at the site where it is generated (see Section 6.5), Figure 9 illustrates that only one out of every six generators (just over 2,300) manage their hazardous waste exclusively on site. Of those 11,800 generators that ship hazardous waste to off-site management facilities for treatment, storage (for more than 90 days), and disposal, roughly 3,100 manage part of their hazardous waste on site. Approximately 8,700 generators ship all of their hazardous waste off site. Some of the latter group reported shipping more hazardous waste off site than they generated. Shipments can exceed generation when inventories of accumulated waste are reduced from one year to the next, or when a facility becomes a transfer point for waste received from off site that is reshipping.

Because the inventory changes and transfer shipments mentioned above are unknown, and because respondents to the survey may not have always rounded the quantity generated and the quantity shipped consistently, the survey's specific estimates in the "some off site" and "all off site" categories shown in Figure 9 are probably less reliable than other characteristic

Figure 9

NUMBER OF GENERATORS SHIPPING HAZARDOUS WASTE OFF SITE IN 1981



estimates provided in this report. Nonetheless, it is clear from the survey results that most generators ship all of their hazardous waste off site for treatment, storage, and disposal, and that only a small portion of the population manages its hazardous wastes exclusively on site.

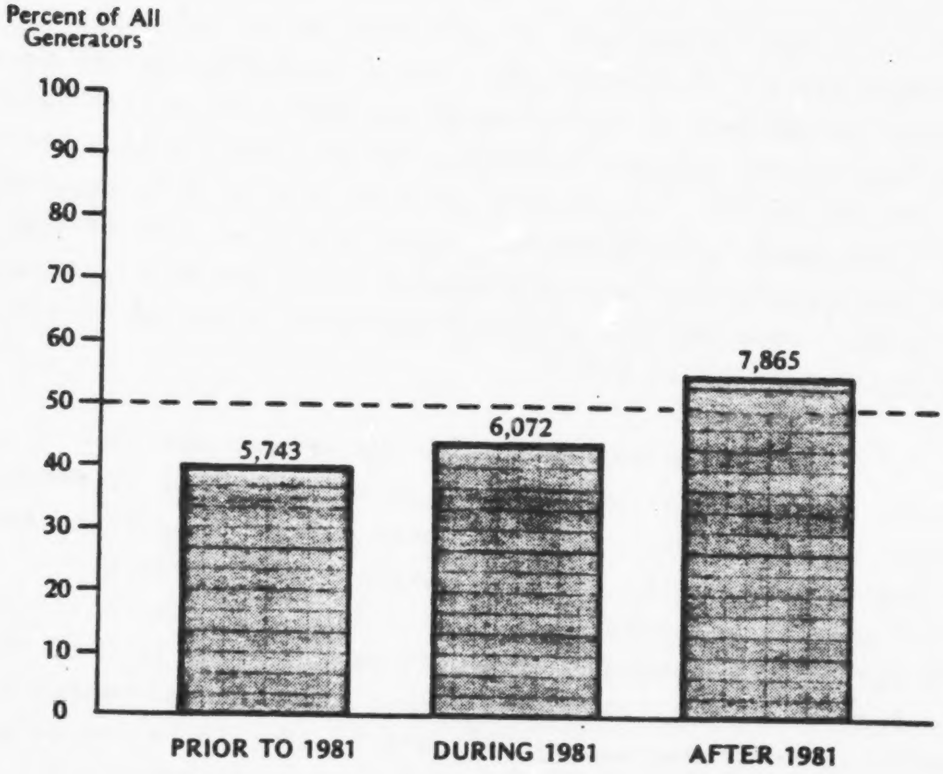
4.5 Number of Generators Recycling Hazardous Waste

Many generators recycle some or all of their hazardous waste. Generators of certain hazardous wastes that recycle 100 percent of their hazardous waste are not subject to RCRA regulations and are therefore not included in this analysis (see 40 CFR 261.6). Those recyclers subject to RCRA regulations (i.e., non-small generators recycling less than 100% of their hazardous waste) have been increasing over time as illustrated in Figure 10. Over half of all generators are expected to recycle hazardous waste after 1981.

Recycled wastes include those that are used or reused, such as for raw materials in production processes; or reclaimed, such as solvent redistillation, scrap metal reclaimed by secondary smelter, or wastes that are blended to make fuels. Of the 14,098 generator population, about 5,700 (41%) are estimated to have generated hazardous waste that was recycled (either on site or off site) before 1981. The number increased to nearly 6,100 generators recycling during 1981 and further increased to more than 7,800 generators that expected to recycle after 1981. This latter number represents 56 percent of the 1981 generators compared to the 43 percent that reported recycling during 1981.

Figure 10

NUMBER OF GENERATORS RECYCLING HAZARDOUS WASTES



Total Generators: **14,098**

The quantity information presented later in Section 6.6 indicates, however, that only a small portion of the total quantity of hazardous waste is actually beneficially used, reused, recycled or reclaimed. The data suggest, therefore, that while a large number of generators recycle at least some hazardous waste, only small portions of their waste streams are actually recycled. It is not known, however, what portion of these waste streams are recyclable. Many factors reduce or eliminate the possibility of recycling, as discussed in greater detail in Section 6.6.

5. DEFINITION AND NUMBER OF MANAGEMENT FACILITIES

Sections 5.1 through 5.5 define hazardous waste management (TSD) facilities and describe their population in terms of the number of facilities in each EPA region, the number of commercial and other types of facilities, number of facilities that treat, store, and dispose of hazardous wastes, and the number of facilities operating specific treatment, storage, and disposal processes.

Hazardous waste management facilities are those involved in the "systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste," as defined in 40 CFR §260.10. Existing TSD facilities were required under RCRA to notify EPA of their hazardous waste management activities by filing Part A permit applications on or before November 19, 1980.

Some types of hazardous waste management are exempt from RCRA regulation. Most notably these include some forms of wastewater treatment and the storage of hazardous waste for less than 90 days.

The hazardous waste management facilities of interest in the surveys discussed in this report are those that actually treated, stored, or disposed of hazardous waste in processes that were regulated under RCRA during 1981. The survey results show an estimated 4,818 facilities meeting these conditions, with a precision of ± 280 facilities at the 95 percent confidence level. The estimate of 4,818 is substantially less than the roughly 8,500 facilities for which EPA currently has Part A applications on file in HWDMS. The difference between the two counts merits some discussion.

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As explained in Section 2.2, prior to undertaking these surveys, the Part A file in the HWDMS data base was closely examined in order to determine whether it would provide a reasonable sample frame from which useful samples of 1981 active TSD facilities could be selected. The following items came to light:

- While Part A permit applications were required to be filed only by facilities "in existence" on or before November 19, 1980, the actual wording of the application forms themselves was somewhat ambiguous. The applications asked respondents to identify the processes that "will be used" to manage hazardous wastes. Thus, many applications were submitted for facilities that were not actually operational at the time of submission during 1981.

- Many facilities filed Part A applications as a precaution, even though they may knowingly not have been actually managing hazardous waste at that time or during 1981. For example, many facilities operating nonhazardous waste management processes (such as trash burning incinerators or solid waste landfills) filed Part A applications to cover those processes in the event that hazardous wastes were ever introduced into them, either accidentally or out of necessity (spill clean-ups, etc.). Other facilities filed Part A applications against the possibility that EPA would expand its hazardous waste listings to cover additional wastes.

- Finally, many facilities filed Part A permit applications mistakenly, either due to misunderstandings about the nature and scope of the RCRA regulations or due to insufficient information about the constituents in their waste streams or the specific nature of their waste management techniques.

For reasons such as those mentioned above, the HWDMS file contains sites in addition to those actually active during 1981. Thus, it does not directly provide the total number of facilities actually engaged in hazardous waste management at a given point in time. The estimate obtained from the current survey was established from a question which specifically asked respondents selected via a probability sample, whether hazardous wastes were actually treated, stored, or disposed of in processes subject to regulation under RCRA in 1981. Thus, the survey provides a direct estimate of the actual number of active management facilities at that time.

As indicated in Section 1.3, however, the survey estimate of the number of active TSD facilities in 1981 is not intended to represent the number of facilities subject to regulation under RCRA at that time or currently. The survey design specifically excluded a variety of regulated facilities, including: regulated sites that were temporarily inactive during 1981;[1] sites that no longer manage hazardous wastes but which, due to prior hazardous waste management and lack of formal closure, are still subject to regulation under RCRA; and sites that may not manage hazardous wastes, or that manage hazardous wastes exclusively in exempt processes, whose "interim status" has not been formally withdrawn under RCRA.

Therefore, the survey systematically understates the magnitude of the population of TSD facilities subject to regulation under RCRA during 1981. The number of facilities subject to regulation under RCRA at any point in time is represented by the number of "valid" Part A permit applications on file at EPA at that time. The number of these facilities has declined since 1980, as facilities that have been determined not to be subject to the RCRA regulations have been formally withdrawn from the regulated community. Until such official actions are taken, however, facilities with valid Part A applications are regulated under RCRA, whether or not they actually processed or handled hazardous waste in 1981.

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[1] As an exception to this, eight eligible incinerator respondents had hazardous waste incinerators that were temporarily shut down or under construction during 1981, but were included in the survey design to obtain additional information about incinerators in these categories.

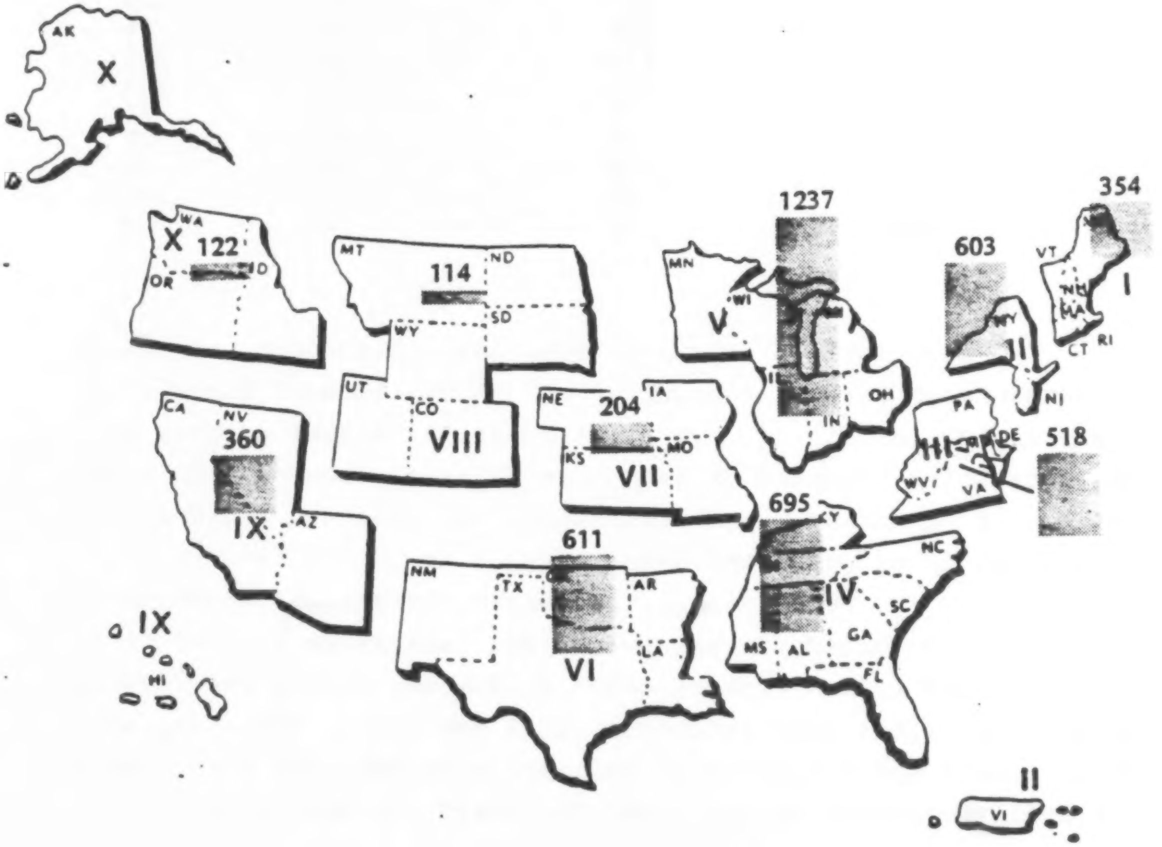
5.1 Regional Distribution of Hazardous Waste Management Facilities

As indicated in the previous section, survey results estimate that 4,818 facilities treated, stored, or disposed of hazardous waste in processes regulated under RCRA during 1981. As discussed earlier, however, this estimate should not be interpreted to represent the number of TSD facilities actually subject to regulation under RCRA in 1981; rather, the 4,818 facilities represent the subset of RCRA-regulated facilities that actually processed or handled hazardous wastes in regulated processes in 1981.

The map presented in Figure 11 depicts the distribution across EPA's ten regions of the number of TSD facilities estimated to have managed hazardous waste in RCRA-regulated processes during 1981. The number of management facilities is concentrated in five of the ten regions. The largest two regions (Regions V and IV) account for 40 percent of the estimated total number of TSD facilities, while 75 percent of the facilities are in the top five regions. Table 8 indicates the percentage distribution of these 1981 active hazardous waste TSD facilities, and compares this distribution with the percentage distribution of TSD facilities identified on the HWDMS Part A file in late 1983 and in mid-1982, at the time the survey samples were drawn from that file.

Figure 11

REGIONAL DISTRIBUTION OF HAZARDOUS WASTE MANAGEMENT FACILITIES IN 1981


AK
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NE
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MO
VII
NM
TX
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AR
LA
VI
MN
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1237
IL
IN
OH
695
KY
NC
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AL
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603
NY
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354
VT
NH
MA
CT
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PA
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DE
MD
WV
VA
518
II
VI

ESTIMATED TOTAL NUMBER OF ACTIVE TSD'S IN 1981: **4,818**

Table 8. Percent of 1981 Hazardous Waste TSD Facilities in EPA Regions - By Rank Order

Rank	Region	Survey Estimated Percent of TSD Facilities 1981	Percentage of Part A Applications Identified on HWDMS File as of: 8-1-83	10-13-83
1	V	26%	22%	27%
2	IV	14%	17%	13%
3	VI	13%	13%	12%
4	II	13%	14%	11%
5	III	11%	10%	11%
6	IX	7%	9%	9%
7	I	7%	8%	9%
8	VII	4%	4%	4%
9	X	3%	1%	2%
10	VIII	2%	2%	2%

From Table 8 it can be seen that there is a very close correspondence between the survey and HWDMS regional distributions of TSD facilities. Thus, although the actual numbers of TSD facilities reported on HWDMS are generally overestimates of the number of active, regulated sites, the relative regional concentration of such facilities appears to be accurately reflected by the HWDMS data. The ranking of regions based on the survey-estimated percentage of 1981 facilities is similar to that obtained from a ranking based on the facilities reported on HWDMS from Part A applications in 1982 and 1983. There is, at most, a four percentage point difference between the percentages for 1981 and either of the other two years for any region.

The precision at the 95 percent confidence level of the survey estimates for the regional percentage of the national number of TSD facilities is conservatively estimated at ± 3.0 percent for each region. Thus, for Region II, the 95 percent confidence interval around the estimate 13 percent is from

10.0 percent to 16.0 percent (13 ± 3.0).[2] However, estimates about the characteristics of facilities in a particular region would be less precise (i.e., would have larger confidence intervals), due to the smaller sample size for any given region. For example, 95 percent confidence limits on estimates of characteristics for facilities found within Region V would be approximately ± 5.9 percent.[3]

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[2] The value ±3.0 percent is a conservative estimate of variability assuming 50 percent of the population has a particular characteristic (e.g., are in a particular region). The actual value grows somewhat smaller as the proportion diverges from 50 percent. To adjust for different proportions and obtain more precise confidence intervals, the conservative estimate (±3.0% for numbers of TSD facilities) can be multiplied by $2\sqrt{(p)(1-p)}$, where "p" is the proportion (expressed as a fraction of 1) of facilities with a certain characteristic. For example, if 13 percent of TSD facilities were in Region II, then substituting .13 for "p," the actual 95 percent confidence interval for that regional estimate would be $(\pm 3.0)(2)\sqrt{(.13)(1 - .13)}$ or ± 2.0 percent. Therefore, we can be 95 percent confident that the percentage of generators in Region II is 13 percent ± 2.0 percent or, in other words, between 11 percent and 15 percent. (Note that when p = .5, the confidence interval is ± 3.0%).

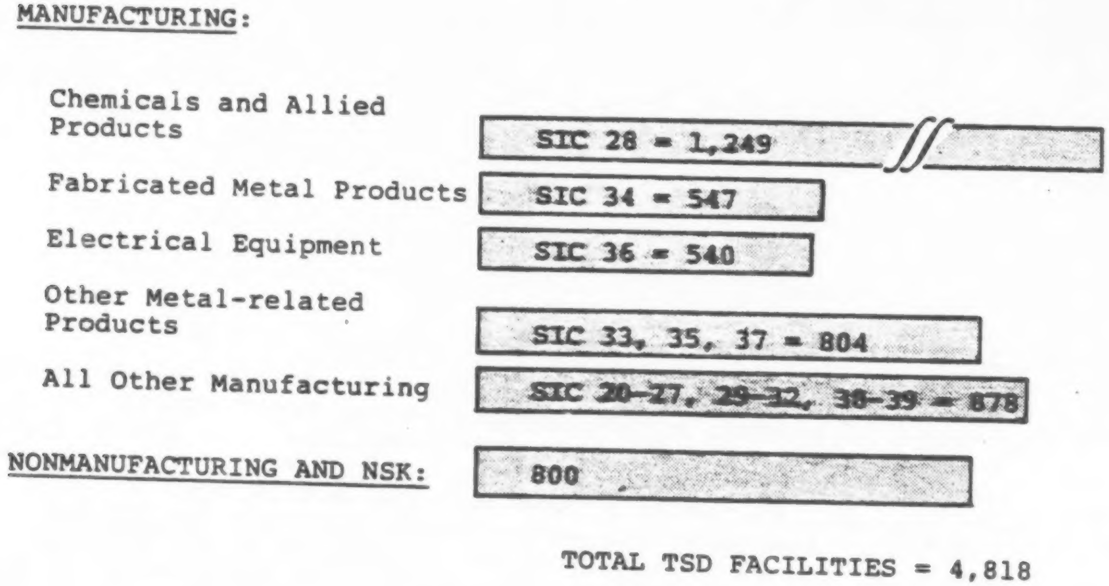
[3] Calculated with the "K" factor (see Table 5) as follows:

$$(3.0)\sqrt{1/p} = (3.0)\sqrt{1/.26} = 5.9$$

5.2 Number of Management Facilities by Industry Type

Facilities engaged in the management of hazardous waste are heavily concentrated in manufacturing industries (primary SIC codes 2000-3999). An estimated 4,018 facilities (83.3% of the total estimate of 4,818) are located at establishments classified as manufacturers. Figure 12 shows the distribution of the number of management facilities across the largest industry categories for which statistically reliable data is available.

Figure 12. Number of Management Facilities by Industry Type



The chemical industry has, by far, the largest number with 1,249 facilities managing hazardous waste, representing a little over one-quarter of all such facilities. The fabricated metal industry and the electrical machinery industry each account for slightly more than 11 percent of the total number of facilities. The remaining facilities are widely distributed over various other industries.

facilities in this report, due to an inability to systematically identify such operations in the survey data base and exclude them. Finally, sites that generated hazardous waste were not necessarily excluded by the definition of this report as long as over half of the hazardous waste managed was generated by independent firms. However, it is believed that much of the hazardous waste generation occurring at these facilities is related to hazardous waste management operations (e.g., landfill leachate, treatment process sludges and residues, etc.), and would not have caused such facilities to be excluded from the Booz-Allen study. Nonetheless, it can not be ascertained from the survey data that the primary business of these sites is commercial waste management. The Booz-Allen study was targeted specifically to such facilities.

The Booz-Allen study was undertaken at a time when attention was focussed on amounts of hazardous waste shipped off site to commercial facilities for management purposes. It was thought that most generators shipped some or all of their hazardous wastes off site for treatment, storage, and disposal. This is consistent with the findings presented in this report (see Section 4.4). However, another finding in this report is that the overwhelming majority of hazardous waste quantities are generated and managed on site by those generators which do not ship the bulk of their hazardous waste off site. Thus, estimates of hazardous waste generation and management activities that are based solely upon an examination of the activities of commercial off-site facilities are likely to be seriously understated. While the Booz-Allen study attempted to address the issue of on-site management, it was forced to rely on secondary data.

5.3 Number of Commercial Management Facilities

For the purposes of this study, a commercial facility has been defined as a privately owned and operated facility that receives more than half of its hazardous waste from firms with which it is not associated by ownership (i.e., that it neither owns nor is owned by). This definition was established in order to provide comparability in the survey's estimates of commercial activity with previous analyses of such operations. The specific nature of the definition was determined through an analysis of the distribution of percentages of interfirm shipments received by facilities in the sample that indicated SIC 4953 (refuse systems) as their primary SIC code. This differs somewhat from the definition employed by the most authoritative source of commercial hazardous waste management activity to date, "Hazardous Waste Generation and Commercial Hazardous Waste Management Capacity," prepared by Booz-Allen & Hamilton, Inc. and Putnam, Hayes and Bartlett, Inc., a 1980 report updated in 1981 and 1982. The Booz-Allen report defined members of the commercial hazardous waste management industry to be "facilities engaged in the treatment and disposal of hazardous waste for a fee, but does not include recovery operations, such as those buying and selling solvents or storage and transfer stations which may be handling wastes classified as hazardous." These facilities solely managed hazardous waste -- they did not generate any themselves.

The major differences in these two definitions may be summarized as follows. First, the definition used in this report assumes that when a firm manages the waste of another, independent firm (i.e., not connected through ownership), it receives financial compensation (a fee) and is thus commercial in nature. Furthermore, some recovery operations and transfer stations that were excluded in the Booz-Allen study are included as commercial

Under the definition used for this report, the survey estimates indicate that there were 326 commercial facilities in 1981 (see Figure 13), representing roughly 7 percent of all TSD facilities. The Booz-Allen estimate was 127 commercial facilities in 1980. Differences in definitions account for some of the difference in estimates. Nonetheless, the survey results indicate substantially greater numbers of commercial facilities than previously estimated. It should be noted that Booz-Allen did not attempt to do a probability sample of all management facilities in its effort to identify commercial facilities. Rather, they contacted those firms that the best information available (based on data from and discussions with EPA and industry trade associations) indicated were likely to be involved in the commercial management of hazardous waste. Since reliable data bases on the generation and management of hazardous waste in the U.S. are still in their formative stages, it is not surprising that the estimates from the two reports differ.

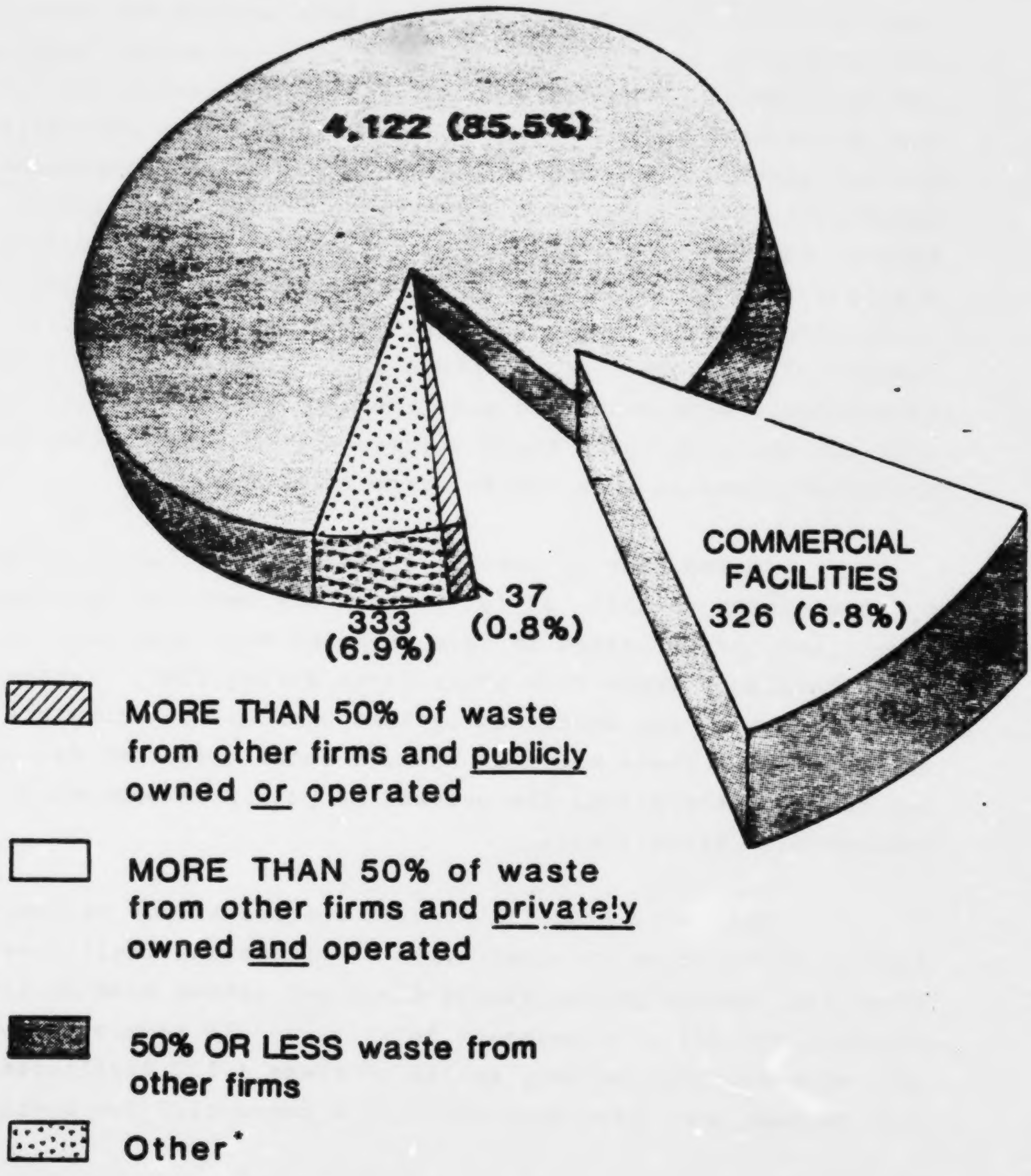
In addition to the 326 commercial facilities estimated by this survey in 1981, 37 (0.8%) publicly owned or operated facilities are estimated to have received more than half of their hazardous waste from other firms during 1981. Another 333 facilities were not specified by kind because of incomplete or missing data. These may also include facilities that did not fit clearly into either the private or public categories (e.g., quasi-public facilities).

Figure 13 also illustrates the prevalence of commercial facilities relative to other types of management facilities. Firms that manage predominantly their own wastes made up the majority (85.5%) of management facilities. It should be pointed out, however, that as many as 146 of these 4,122 facilities may have managed some hazardous waste on a commercial fee basis,

Figure 13

NUMBER OF COMMERCIAL VERSUS OTHER TSD FACILITIES

Total TSD's: 4,818



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*Includes 324 facilities not specified by kind due to missing data, and 9 facilities not elsewhere classified (eg. quasi-public facilities) even though the quantity of such waste was exceeded by the quantity of hazardous waste managed noncommercially.

The Office of Solid Waste (OSW), in its efforts to identify commercial facilities among those on file on HWDMS, does not limit its definition in the way that both this report and the Booz-Allen study have. Specifically, OSW defines as commercial any facility that offers its services of hazardous waste management as a business for a price. Commercial waste management need not be the primary business activity at the site. Nor are reclaimers or transfer stations excluded. This is the broadest definition of commercial facilities; both the population identified in Figure 13 and the Booz-Allen population are subsets of this broader population. Using the assumption stated above, that receipt of hazardous wastes from firms not owning or owned by the facility is an indicator that hazardous wastes are managed as a business for a price, the survey estimates that as many as 509 facilities would have qualified as commercial facilities in 1981 under OSW's broader definitions.

OSW's reason for employing this broad definition is to ensure the inclusion of all quantities of hazardous waste managed in a commercial manner and to identify the broadest population of facilities that may be available to generators that do not treat, store, or dispose of all of their hazardous wastes on site. Alternatively, the definition developed for this report, which allows comparability with previous studies, ignores commercial quantities handled by firms at which the commercial quantities comprise less than 50 percent of the managed waste. However, the commercial quantities managed by these "non-commercial" firms may be large (see Section 7.6), particularly for firms managing exceptionally large quantities of waste. Thus, the OSW definition of commercial facilities, which includes such facilities, may be the most appropriate definition.

5.4 Number of Facilities Treating, Storing, and/or Disposing of Hazardous Waste

Survey results indicate that hazardous waste storage is the most prevalent management activity regulated under RCRA. Of the 4,818 TSD facilities, 89.2 percent are estimated to have stored hazardous waste in regulated storage processes during 1981. (See Figure 14.) This estimate excludes any sites where hazardous wastes were stored (accumulated) on site for less than 90 days in tanks or containers (exempt 90-day accumulation). Storage is an essential aspect of the hazardous waste management cycle. Section 5.4.2 below provides a comparative analysis of the utilization of the different types of regulated storage processes (containers, tanks, waste piles, and surface impoundments) for hazardous waste storage during 1981.

An estimated 1,495 facilities (or 31.0%) treated hazardous wastes in processes regulated under RCRA during 1981.[4] (See Figure 14.) However, a significant, but unestimable number of additional facilities and generators also treated hazardous wastes during 1981, but did so in processes that have been specifically exempted or excluded from regulation under RCRA. The most prevalent example of these exempt treatment processes is hazardous wastewater treatment in tanks that are covered by NPDES permits. As discussed in Section 2.3, lack of a valid sample frame prevented the development of statistically valid estimates of the number of facilities utilizing such exempt procedures. Nonetheless, the frequency at which they were observed during the survey process suggests that the number

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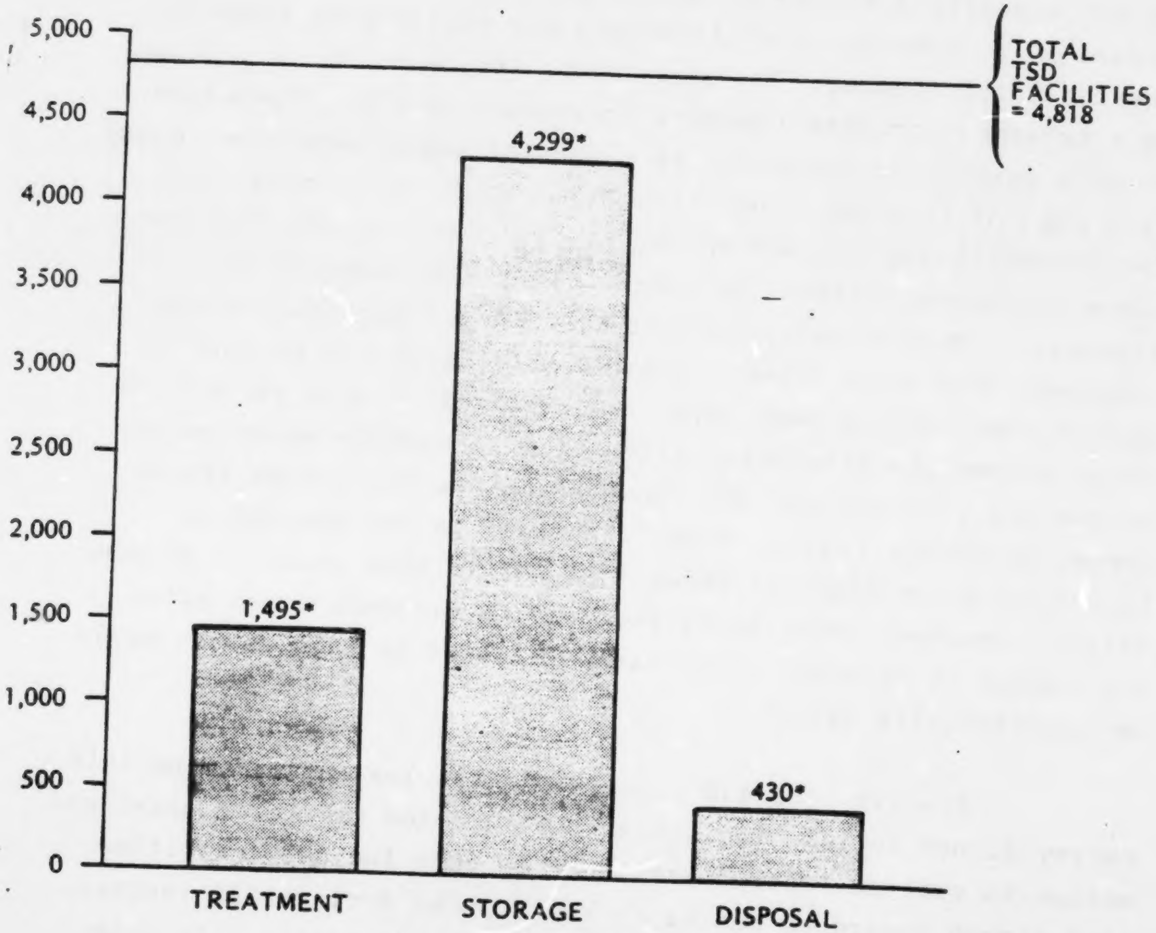
[4] This number may be slightly overstated to the extent that respondents may have failed to exclude exempted wastewater treatment tanks from the TSD General Questionnaire where all treatment took place exclusively in these tanks.

Figure 14

NUMBER OF FACILITIES WITH TREATMENT, STORAGE, AND/OR DISPOSAL IN 1981



*Treatment + Storage + Disposal exceeds 4,818 due to multiple processing at facilities. Some treatment facilities shown here may be RCRA-exempt (see footnote on previous page).

of regulated treatment facilities estimated by this survey significantly understates the role played by treatment (both regulated and exempt) in the management of hazardous waste. Section 5.4.1 below presents a comparative analysis of the utilization of the types of regulated hazardous waste treatment processes (tanks, surface impoundments, and incinerators) for RCRA-regulated hazardous waste treatment during 1981.

Based on the survey, only an estimated 430 facilities (8.9%) actually disposed of hazardous wastes during 1981. (See Figure 14.) However, clarifications are required to properly interpret this number. To begin with, incineration is regarded as a treatment process (thermal treatment) by EPA. Therefore, in this survey, incineration is a form of waste reduction, which is a form of treatment, not disposal. Thus, facilities that incinerated hazardous wastes during 1981 are not included among these 430 sites (unless, of course, they also engaged in disposal). Furthermore, many other forms of hazardous waste treatment represent "final" treatment: wastes are treated to render them nonhazardous (e.g., neutralized). Once so treated, these wastes are frequently discharged to surface water bodies or similarly "disposed" of. However, since the wastes are no longer hazardous wastes, such "disposal" is not counted as hazardous waste disposal under RCRA nor in this survey. If such "final" treatment were to be regarded as disposal under RCRA, the number of disposal facilities estimated by this survey would be substantially larger.

Finally, the 430 disposal facilities estimated by this survey do not include facilities that treated or stored hazardous wastes in surface impoundments, nor do they include facilities that stored hazardous wastes in waste piles during 1981 (unless, of course, such facilities also engaged in disposal). In this way, the population of "disposal" facilities estimated in this section differs significantly from the population of "land disposal" facilities subject to EPA's RCRA regulations. EPA considers "land disposal" facilities to include all hazardous waste landfills, land treatment areas, waste piles, and all types of surface impoundments. Such facilities are subjected to a variety of specific standards, including, but not limited to, groundwater monitoring and response, and extensive closure and post-closure care requirements. Not included among EPA's "land disposal" facilities, which generally include only those facilities that are required to perform groundwater monitoring under RCRA, are underground injection wells and ocean disposers. Both of these types of facilities are, however, included in the population of "disposal" facilities estimated in this section, along with landfills, land treatment areas, and disposal surface impoundments. There were an estimated 1,049 "land disposal" facilities (21.8% of the total) actively employing such processes during 1981. If underground injection wells were to be added to this group (those not already included due to the operation of other disposal processes), the estimate would be 1,063 (22.1% of the total).

Section 5.4.3 below presents a comparative analysis of the various types of disposal processes observed during the survey (underground injection wells, landfills, land treatment areas, and disposal surface impoundments) utilized for hazardous waste disposal in 1981.

The sum of the percentages presented for treatment (31.0%), storage (89.2%) and disposal (8.9%) facilities exceeds 100 percent because many facilities employ more than one such process in their hazardous waste management operations. Together, the survey's estimates of the numbers of treatment, storage, and disposal facilities provide an interesting picture of the RCRA-regulated population of TSD facilities in 1981. More than half of the population does nothing more than store hazardous wastes (at least 2,893 facilities, which was obtained by subtracting from the 4,818 facilities all 430 disposal sites and, assuming conservatively that none of the treatment processes are located on the same sites as disposal processes, further subtracting all of the 1,495 treatment sites). Some of these storage sites are transfer stations (the survey did not distinguish transfer stations, and therefore cannot estimate their numbers). Others are long-term storage sites or sites that employ waste piles or surface impoundments. But the majority of these storage facilities would appear to be tanks and container areas employed on site by generators to store hazardous waste, for periods of more than 90 days, prior to shipment off site for treatment and disposal.

As indicated in Section 4.4 above, most generators (62%) ship all their hazardous wastes off site for treatment, storage and disposal. One possible conclusion that might be implied in the findings presented in this section is that most facilities also ship, or intend to ship (since they do not treat or dispose on site) all their hazardous wastes off site for treatment and disposal. This conclusion cannot, unfortunately, be confirmed directly from the survey itself, because the facility questionnaires did not obtain data on shipments from the facilities. Nonetheless, the numbers presented in this section suggest that a great many, if not the majority, of the facilities regulated under RCRA during 1981 performed only an interim role in the management of hazardous wastes.

5.4.1 Number of Facilities Treating Hazardous Waste, by Treatment Process Type

The survey results revealed that treatment of hazardous waste in tanks was the most commonly used treatment process during 1981. Approximately 41 percent (or 609) of the 1,495 treatment facilities treated hazardous waste in tanks. About one out of every eight (12.6%) of the 4,818 TSD facilities employed treatment tanks in their management of RCRA-regulated hazardous wastes. In addition, many more facilities indicated that they treat hazardous wastewaters in tanks covered under National Pollutant Discharge Elimination System (NPDES) permits. As is indicated in Section 1.3, such tanks are excluded from regulation under RCRA, and the survey was not designed to provide estimates of the numbers of facilities operating tanks under NPDES permits during 1981. The large number of NPDES tank facilities and/or processes observed among survey respondents, however, suggests that treatment in tanks, as a general hazardous waste management technology, is employed more heavily than the estimate of RCRA-regulated tank treatment sites would indicate.

Treatment of hazardous waste in surface impoundments emerged as the second most commonly used treatment process during 1981. Survey estimates indicate that treatment surface impoundments were in use at 27.4 percent (or 410) of the 1,495 treatment facilities. About one out of every twelve (8.5%) of the 4,818 TSD facilities employed treatment surface impoundments in their management of RCRA-regulated hazardous wastes during 1981. Unlike treatment tanks, treatment surface impoundments that are employed to treat hazardous wastewater under NPDES permits are not excluded from RCRA regulation. Thus the estimated number of facilities with treatment surface impoundments includes facilities that are only engaged in NPDES wastewater treatment in surface impoundments, while the estimated number of facilities with treatment tanks excludes those facilities that are only engaged in NPDES wastewater treatment in tanks. Therefore, the estimate of the number of hazardous waste treatment surface impoundments is not likely to understate the role surface impoundments play in hazardous waste treatment.

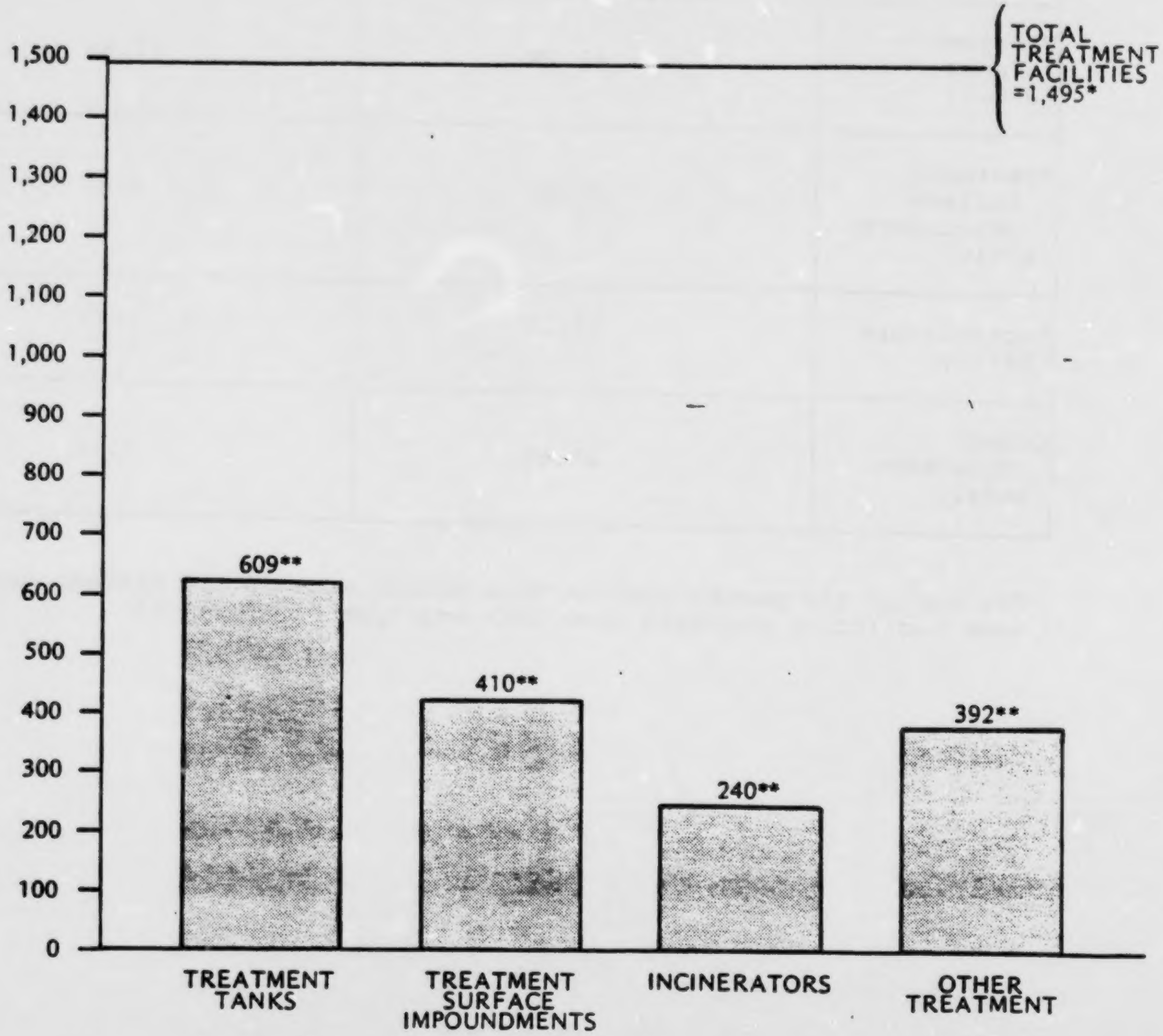
Incineration was the least frequently employed treatment alternative among the three treatment technologies specified in the survey questionnaire. About 16 percent (or 240) of the 1,495 treatment facilities were estimated to have used incineration in their treatment of hazardous waste during 1981. One out of every twenty (5.0%) of the 4,818 TSD facilities employed incinerators for hazardous waste treatment. While there were fewer facilities employing incineration than any other hazardous waste treatment alternative, it should be noted that the estimated number of facilities that used incineration to treat hazardous waste was greater than the number of facilities that employed the most commonly used disposal method, landfilling. (There were an estimated 240 incinerator sites during 1981, compared to 199 landfill sites; see Section 5.4.3.)

More than 25 percent of the treatment facilities indicated that they also treated hazardous waste in processes other than the three treatment processes specified in the survey questionnaire. Other treatment processes listed by respondents included open burning, explosion, treatment in containers, and treatment in waste piles. About 8 percent (one out of every 12) of the 4,818 TSD facilities listed "other treatment" as one of their hazardous waste management technologies. In most cases, facilities reporting "other" treatment methods also reported the more common methods (tanks, impoundments and incinerators). In addition, some technologies classified by respondents as "other" may prove to be classifiable as treatment in tanks or impoundments.

Figure 15 on the following page, presents the estimated number of sites employing RCRA-regulated tank, surface impoundment, incinerator, and other treatment processes in their management of hazardous waste during 1981. Table 9, following, presents the percentages of treatment facilities and TSD facilities that used each treatment process type.

Figure 15

NUMBER OF FACILITIES TREATING HAZARDOUS WASTE IN 1981, BY TREATMENT PROCESS TYPE



*Some of these treatment facilities may be RCRA-exempt (see Section 5.4 footnote)

**Tanks + Impoundments + Incinerators + Other exceeds 1,495 because some facilities had more than one treatment type.

Table 9. Percentage of Treatment Facilities and of All TSD Facilities Employing Each Treatment Technology in 1981

Process Type	Percent of 1,495 Treatment Facilities Employing Process Type*	Percent of 4,818 TSD Facilities Employing Process Type
Treatment Tanks (N=609)	40.7%	12.6%
Treatment Surface Impoundment (N=410)	27.4%	8.5%
Incinerators (N=240)	16.1%	5.0%
Other Treatment (N=392)	25.8%	8.1%

*The sum of the percentages in this column exceeds 100 percent because some facilities employed more than one type of treatment.

5.4.2 Number of Facilities Storing Hazardous Waste, by Storage Process Type

Survey results indicated that storage in containers was the most commonly used type of hazardous waste storage during 1981. "Container" is defined by 40 CFR, Subpart B §260.10 as "any portable device in which material is stored, transported, treated, disposed of, or otherwise handled." Fifty-five gallon metal drums are commonly used as hazardous waste containers. Other containers include 25 gallon plastic drums, tank cars, tank trucks, and, for some acutely hazardous waste, glass vessels.

An estimated 85 percent (or 3,577) of the 4,299 hazardous waste storage facilities used storage in containers as a method of storing hazardous waste. Almost three out of four (74.2%) of all 4,818 TSD facilities used containers for storing hazardous waste. In addition, many more TSD facilities indicated that they accumulated hazardous waste generated on site, for less than 90 days, in containers. As is indicated in Section 1.3, on-site accumulation of hazardous waste for less than 90 days in containers is excluded from most regulation under RCRA. The TSD facility survey was not designed to estimate the number of facilities using on-site accumulation in containers. Estimates from the TSD Generator Questionnnaire, however, suggest that, during 1981, about 51 percent of the 14,098 hazardous waste generators used containers to accumulate hazardous waste for less than 90 days.

Storage in tanks emerged as the second most commonly used type of hazardous waste storage during 1981. This storage method was used by 33.2 percent of the 4,299 hazardous waste storage facilities during 1981. Better than one out of every four (29.6%) of the 4,818 TSD facilities stored hazardous waste in tanks during 1981. In addition, many more facilities indicated that they used tanks to accumulate hazardous waste generated on site for less than 90 days. As indicated in Section 1.3, on-site accumulation of hazardous waste in tanks for less than 90 days is excluded from most regulation under RCRA. The TSD facility survey was not designed to estimate the number of facilities using on-site accumulation in tanks. Estimates from the Generator Questionnaire, however, suggest that, during 1981, about 15 percent of the 14,098 hazardous waste generators used tanks to store hazardous waste for less than 90 days.

Hazardous waste storage tanks that are used exclusively as part of a wastewater treatment system covered under a National Pollutant Discharge Elimination System (NPDES) permit are exempted from regulation under RCRA. This survey of RCRA-regulated facilities was not designed to provide estimates of the number of facilities that operated storage tanks under NPDES permits during 1981. However, the large number of NPDES facilities and/or processes observed among survey respondents (both in the Tank Questionnnaire data file and in the Generator Questionnaire data file) suggests that storage in tanks, as a general hazardous waste management technology, is employed much more frequently than the estimate of RCRA-regulated storage in tanks suggests.

About one-eighth of the 4,299 storage facilities (12.8% or 552 facilities) stored hazardous waste in surface impoundments during 1981. About one in every nine (11.5%) of all 4,818 TSD facilities stored hazardous waste in surface impoundments in 1981. The 90-day storage exclusion rule that applies to on-site accumulation of hazardous waste in tanks and containers (see above, and Section 1.3) does not apply to generators who store hazardous waste in storage surface impoundments. Thus, unlike the counts for containers and storage tanks, the counts for storage surface impoundments include impoundments in which hazardous waste was stored for any amount of time, by any type of facility, and are therefore not likely to understate the role played by surface impoundments in hazardous waste storage.

Furthermore, unlike storage tanks, storage surface impoundments that are employed to store hazardous wastewater under NPDES permits are not excluded from RCRA regulation. Thus, the estimated number of facilities with storage surface impoundments includes facilities that are only engaged in NPDES wastewater storage in surface impoundments, while the estimated number of facilities with storage tanks excludes those facilities that are only engaged in NPDES wastewater storage in tanks.

Hazardous waste storage in waste piles was the least frequently used storage method among the four storage methods listed in the TSD General Questionnaire. Approximately 4.0 percent (or 174) of all of the 4,299 storage facilities and 3.6 percent of all 4,818 TSD facilities used waste piles as a method of storing hazardous waste during 1981. Less than 1 out of every 25 TSD facilities stored hazardous waste in waste piles in 1981. At the time this survey was developed, waste piles were regarded by the EPA as only a storage process. Waste piles are now recognized as a possible disposal process, and are therefore regulated under more stringent standards (e.g., requiring ground water monitoring). Since the survey dealt only with storage waste piles, estimates of the number of waste piles used for treatment and/or disposal cannot be made.

Approximately 3 percent of the 4,299 storage facilities (3.2% or 139 facilities) stored hazardous waste in storage methods other than containers, tanks, impoundments or waste piles. These facilities represent 2.9 percent of all 4,818 TSD facilities.

Figure 16 presents the number of container, tank, surface impoundment, waste pile and other storage facilities that stored hazardous waste in 1981. Table 10 presents the percentage of storage facilities and TSD facilities that employed each storage process type.

5.4.3 Number of Facilities Disposing of Hazardous Waste, by Disposal Process Type

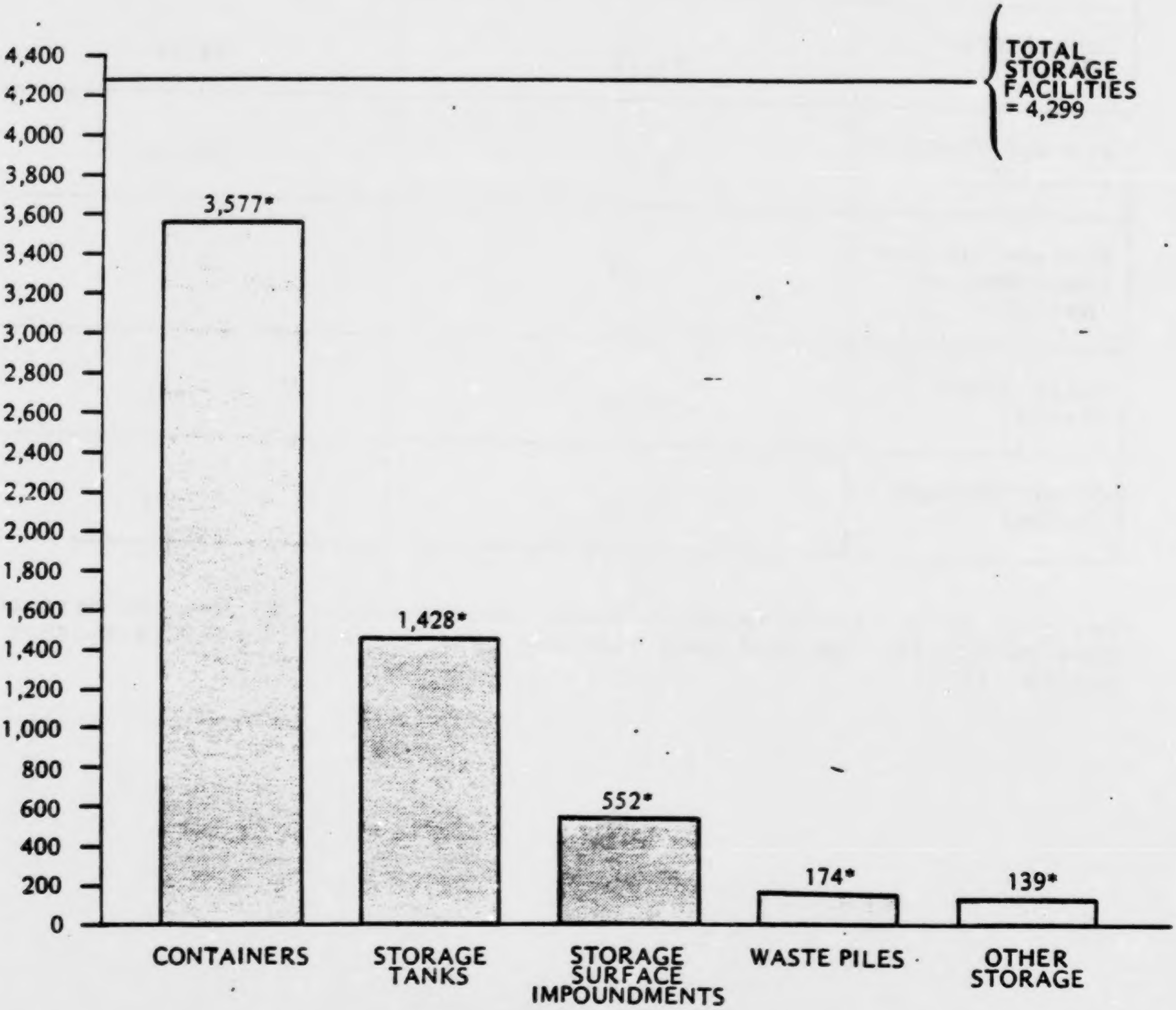
According to survey results, the most frequently used method of disposal of hazardous waste during 1981 was landfilling. Almost one half (46.3% or 199) of the 430 disposal facilities used landfills for disposal of hazardous waste during 1981. About 1 in 25 (4.1%) of all 4,818 TSD facilities actively landfilled hazardous wastes in 1981.

Disposal in surface impoundments emerged as the next most frequent method of hazardous waste disposal in 1981. This technology was used by 27.0 percent (or 116) of the 430 disposal facilities. About 1 out of every 40 (2.4%) of the 4,818 TSD facilities used surface impoundments for disposal of hazardous waste.

Disposal in underground injection wells was the third most frequently used method of hazardous waste disposal in 1981, with approximately one-fifth of the disposal facilities using this method. About 20.2 percent (or 87) of the 430 disposal facilities used injection wells for disposal in 1981. This represents approximately 1 out of every 55 (1.8%) of the 4,818 TSD facilities. As indicated in Section 7.7.3, however, underground injection is estimated to have accounted for the overwhelming majority of the quantity of hazardous wastes disposed of during 1981.

Figure 16

NUMBER OF FACILITIES STORING HAZARDOUS WASTE IN 1981, BY STORAGE PROCESS TYPE



*Containers + Tanks + Impoundments + Piles + Other exceeds 4,299 because some facilities used more than one storage method.

Table 10. Percentage of Storage Facilities and of All TSD Facilities Employing Each Storage Technology in 1981

Process Type	Percent of 4,299 Storage Facilities Employing Process Type*	Percent of 4,818 TSD Facilities Employing Process Type*
Containers (N=3,577)	83.2%	74.2%
Storage Tanks (N=1,428)	33.2%	29.6%
Storage Surface Impoundments (N=552)	12.8%	11.5%
Waste Piles (N=174)	4.0%	3.6%
Other Storage (N=139)	3.2%	2.9%

*The sums of the percentages in these columns exceed 100 percent because some facilities employed more than one type of hazardous waste storage during 1981.

Disposal by land application (treatment) was the least common of the four specified disposal methods. Approximately one-sixth (16.3% or 70) of the 430 disposal facilities disposed of hazardous waste by land application during 1981. A very small proportion, approximately 1 in 70, or 1.5 percent, of all 4,818 TSD facilities were land application facilities during 1981.

A very small number of facilities reported using some other method for the disposal of hazardous waste (e.g., ocean disposal, disposal in waste piles, etc). About 1.6 percent (or 7) of the 430 disposal facilities used other disposal methods during 1981. This represents less than one percent (0.1%) of all 4,818 TSD facilities.

Figure 17, on the following page, presents the number of TSD facilities with landfills, surface impoundments, injection wells, land application (treatment) facilities, and other disposal processes used for disposing of hazardous waste in 1981. Table 11, following, presents these numbers as percentages of all disposal facilities and of the total number of RCRA-regulated TSD facilities in 1981.

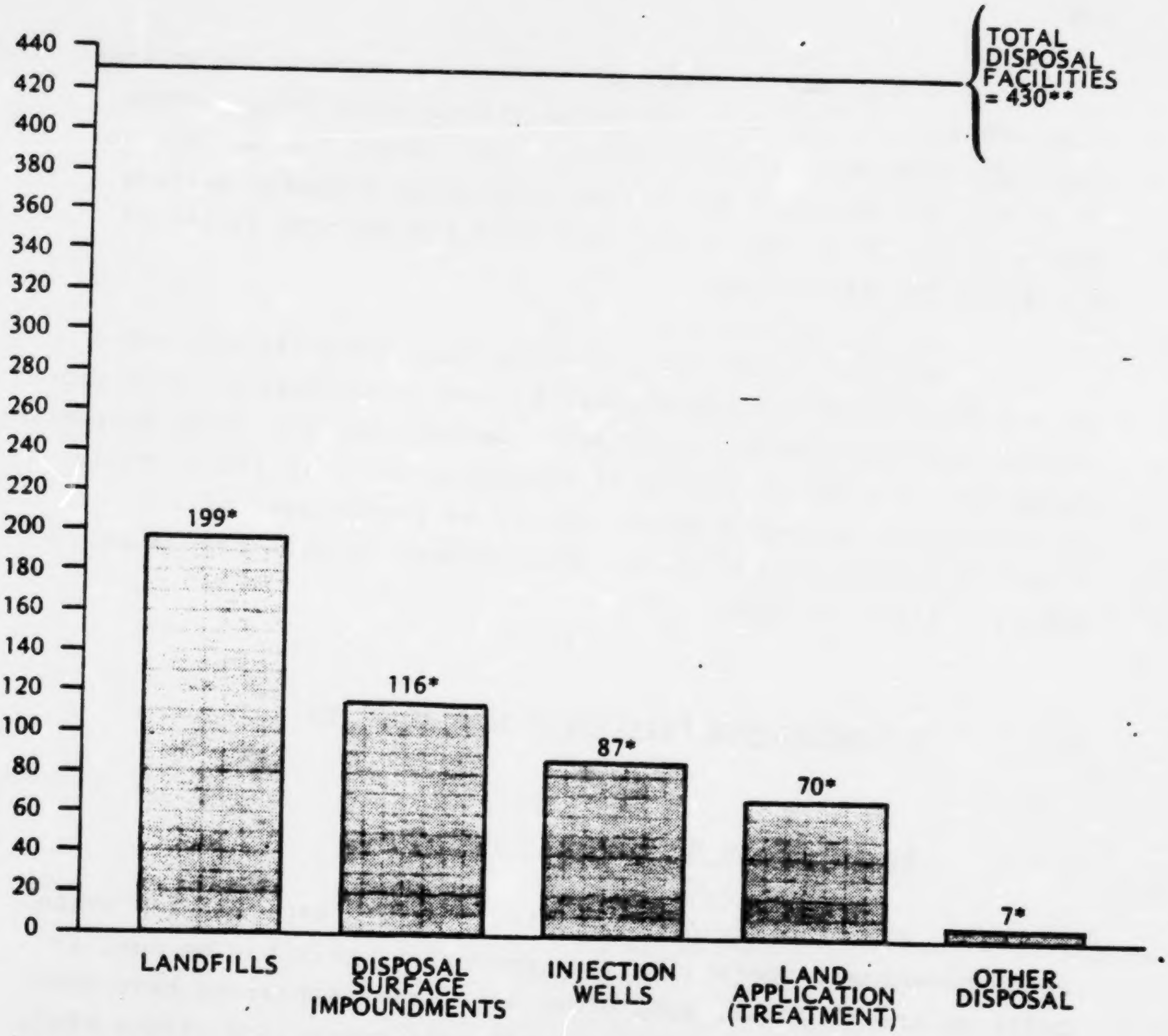
5.5 Miscellaneous Facility Characteristics

5.5.1 Age of Waste Management Facilities

The majority of facilities with TSD capabilities began waste management operations very recently. This may be due, in part, to the fact that many older facilities appear to have shut down or ceased hazardous waste management operations before EPA's RCRA regulations took effect. Table 12 presents the age distribution of RCRA-regulated hazardous waste management facilities as of 1981, based on the survey results.

Figure 17

NUMBER OF FACILITIES DISPOSING OF HAZARDOUS WASTE IN 1981, BY DISPOSAL PROCESS TYPE



*Landfills + Impoundments + Wells + Land Application + Other exceeds 430 because some facilities used more than one disposal method.

**Does not include waste piles or surface impoundments used for treatment or storage of hazardous waste.

Table 11. Percentage of Disposal Facilities and of all TSD Facilities Employing Each Disposal Technology in 1981

Process Type	Percent of 430 Disposal Facilities Employing Process Type*	Percent of 4,818 TSD Facilities Employing Process Type
Landfills (N=199)	46.3%	4.1%
Disposal Surface Impoundments (N=116)	27.0%	2.4%
Injection Wells (N=87)	20.2%	1.8%
Land Application (Treatment) (N=70)	16.3%	1.5%
Other Disposal (N=7)	1.6%	0.1%

* The sum of the percentages in this column exceeds 100% because some facilities employed more than one type of disposal.

Table 12. Age Distribution of TSD Facilities

Age (in years) of Facility in 1981	Percentage in Class	Cumulative Percentage
0-1	29.0	29.0
2-3	11.4	40.4
4-6	15.6	56.0
7-15	18.7	74.7
16-30	14.2	88.9
31-40	6.4	95.3
40+	4.7	100.0

In 1981 over half of the facilities' waste management operations were six years old or less. In fact, almost 30 percent of the facilities commenced waste management operations in 1980 or 1981. Three-fourths of the facilities began waste management, at most, 15 years ago, while nearly 90 percent began within the past 30 years. This heavy concentration of new waste management facilities corresponds to the recent attention and concern given to the problems of handling hazardous waste, but may also be due to the pre-RCRA closure of older facilities. The survey was not designed, however, to estimate the number of such closures.

5.5.2 Ownership Status of TSD Facilities

The ownership of facilities involved in the treating, storing, or disposing of hazardous waste in 1981 was predominantly private. Table 13 shows the ownership status of the facilities.

Privately owned TSD facilities accounted for 90 percent of the population. Those facilities solely owned by the Federal government represented approximately four percent of the population. Solely state and solely local owned facilities accounted for about one percent each, while the remaining three percent fell in a miscellaneous or "other" categorization of ownership.

Table 13. Ownership Status of TSD Facilities

Ownership Status	Percentage of Total*
Solely Federal government	4.3
Solely State government	1.3
Solely local government	1.1
Privately owned	90.0
Other	3.2

*Does not add to 100 due to rounding.

5.5.3 Operator Status of TSD Facilities

As with ownership, the operation of facilities treating, storing, and disposing of hazardous waste was predominantly private in 1981. Table 14 shows the operator status of the facilities.

Table 14. Operator Status of TSD Facilities

Operator Status	Percentage of Total
Solely federal government	3.2
Solely state government	1.2
Solely local government	0.5
Privately operated	92.4
Other	2.7

The distribution of operator status is very similar to that of ownership status. Private operators account for over 92 percent of the population, while government operation is represented by 3 percent Federal, 1 percent State, and one-half percent local. The remaining 3 percent is accounted for by "other" approaches to handling the operation of TSD facilities.

Comparing the distributions of ownership and operator status, the survey results indicate that a portion of government owned facilities are actually operated by the private sector. Examples include private research facilities located at government installations, private industries located at military installations, and the contracting out of the operations of waste management facilities to private enterprises by State and local governments. The end result of these factors, combined with the heavy concentration of facility ownership in private hands, is that the day-to-day responsibility for the treatment, storage, and disposal of hazardous waste in the United States is being managed almost exclusively by private enterprise.

PART III (Sections 6-7)

QUANTITIES

OF

HAZARDOUS WASTE

INTRODUCTION TO PART III:

QUANTITIES OF HAZARDOUS WASTE GENERATED AND MANAGED

As detailed in Section 1.2, one of the purposes of conducting the survey was to develop estimates of the quantity of RCRA-regulated hazardous wastes generated during 1981, and the quantities of hazardous wastes treated, stored, and disposed of in RCRA-regulated processes during 1981. Part II (Sections 4 and 5) of this report summarized the survey's major findings concerning the numbers and characteristics of the generators and TSD facilities regulated under RCRA. Part III (Sections 6 and 7) presents a summary of survey results pertaining to the various quantities of hazardous waste regulated under RCRA during 1981. Survey-based estimates of the quantities of hazardous waste generated in 1981 are presented initially (Section 6), followed by a presentation of the estimated quantities of hazardous waste that were managed (treated, stored, and disposed of) in processes subject to regulation under RCRA during 1981 (Section 7).

Before presenting the hazardous waste quantity estimates, however, it is necessary to present a brief overview of those aspects of the survey design that particularly affected the quantification of hazardous waste generation and its subsequent treatment, storage, and disposal under RCRA. The survey design played an important role in defining the specific nature of the quantity estimates developed from the obtained data, and should be understood clearly in the interpretation of the findings presented in Sections 6 and 7 below.

Statistical Reliability of Quantity Estimates

As detailed in Section 3.3, the survey's estimates concerning quantities of hazardous waste generated and managed in 1981 are subject to substantially greater statistical uncertainty than are its estimates of population characteristics. This greater uncertainty results, primarily, from two factors:

1) The survey samples were designed to provide more accurate characteristic data (for reasons described in Section 2.3); and,

2) The populations of hazardous waste generators and TSD facilities were both found to be highly skewed in terms of the quantities of hazardous wastes they generate and manage; so skewed, in fact, that very small proportions of the populations account for nearly all of the quantities generated and managed (see Figures 3 and 4).

These two factors, generally categorized as "sampling error" (see Section 3.1), are responsible for the wide confidence intervals surrounding the quantity estimates presented in the following sections.

Sampling error had a particularly severe impact on the quantity estimates derived from the Generator Questionnaire. As discussed briefly in Section 3.3 and summarized in Table 3, sampling error related to the design of the Generator Survey and the skewed distribution of the generator population resulted in a confidence interval of plus or minus 79.7 percent surrounding the Generator Questionnaire's estimate of total quantity of hazardous waste generated during 1981. This confidence interval is 63 percent wider than the interval surrounding similar estimates derived from the TSD General Questionnaire. The reasons behind the differences between these confidence intervals are essentially related to the greater impact of sampling error in the Generator Survey than in the TSD Facility Survey: sampling error was reduced in the survey of TSD facilities because, by focusing on sites with TSD facilities, the TSD survey included a higher proportion of the larger sites than did the Generator Survey. Since the larger sites account for the greatest proportions of the quantities generated and managed, their heavier representation in the facility sample served to improve the precision of the estimates.

The severe impact of sampling error in the Generator Survey prompted the development of an alternate mechanism for deriving an estimate of the total quantity of hazardous waste generated during 1981. This alternate mechanism, described in detail in Section 6, essentially divides the generation estimate into two components: the quantity of hazardous waste generated by generators that do not operate on-site TSD facilities, and the quantity generated by generators that do operate on-site TSD facilities. Since the TSD facility survey is acknowledged to provide more precise quantity estimates for the subpopulation of sites with TSD facilities, a proxy generation estimate was derived from the TSD General Questionnaire and substituted in place of the same estimate provided by the Generator Questionnaire for that segment of the population. The Generator Questionnaire is still utilized to derive the other piece of the total generation estimate, that from generators without on-site TSD facilities. These two estimates are then added together to form the estimate for the total quantity of hazardous waste generated in 1981.

Development of this alternate mechanism for estimating the total quantity of hazardous waste generated in 1981 resulted in a significant reduction in the uncertainty surrounding that estimate, due to greater reliance upon that part of the survey, the TSD facility sample, that was subject to reduced sampling error. The alternate estimation mechanism also provides for greater consistency between the estimates of hazardous waste generation and its subsequent management, as discussed in detail in Sections 6 and 7.

Nonsampling error also is believed to be involved to a greater extent in relation to the quantity estimates (from both the Generator and TSD General Questionnaires) than in relation to the population characteristic estimates presented in Part II. As discussed in detail in the following section, greater nonsampling error is associated with the quantity estimates due to the high degree of complexity inherent in trying to measure the quantities of hazardous waste subject to regulation under RCRA.

As a result of the greater uncertainties (related to sampling and nonsampling error) associated with the survey's quantity estimates, and due to the fact that the survey was designed to provide national estimates, regional breakdowns of the estimates of the quantities of hazardous wastes generated and managed in 1981 are not provided. Regional breakdowns of the numbers of generators and TSD facilities are provided in Part II, despite the national nature of the survey design, due to the high level of precision obtained for estimates of population characteristics. Such precision was not obtained for the quantity estimates and, as such, presentation of regional breakdowns of the quantity estimates could be seriously misleading.

Other quantity data presented in the following sections should be interpreted and utilized within the context of the discussion of statistical reliability issues presented in Sections 3.3 and 3.4.

Definition of Hazardous Wastes Included in Survey Estimates

Two features of EPA's RCRA hazardous waste regulatory program significantly impacted the quantity estimates presented in the following sections: 1) rules governing the mixtures of hazardous and nonhazardous wastes; and 2) exemptions and exclusions of specific wastes and specific waste management processes from regulation under Subtitle C of RCRA. Each of these issues contributed to the complexities faced in attempting to measure the quantities of hazardous wastes regulated under RCRA during 1981; each contributed to increased uncertainty surrounding the survey's quantity estimates in the form of "nonsampling error" (see Section 3.1). The ramifications of RCRA's exemptions and exclusions will be addressed initially, followed by a discussion of the impacts of the mixture rules on the survey's quantity estimates.

Exemptions and Exclusions

As stated in Section 1.3, the national survey was designed to estimate the quantities of hazardous waste that were generated in 1981 and were or were intended to be managed subsequently in processes subject to regulation under RCRA. This represents a very narrow definition of the types of hazardous wastes that are included in the survey's quantity estimates, and needs to be understood clearly in order to properly interpret the findings presented in the following sections.

Specifically, two categories of waste streams are not included in the survey's hazardous waste quantity estimates:

1) Wastes that have been exempted or excluded from regulation under RCRA as hazardous wastes; and,

2) RCRA-regulated hazardous wastes that were generated in 1981 but that were not, at any point in the management process, treated, stored, or disposed of in processes subject to regulation under RCRA.

Most prominent among the waste streams that have been excluded from regulation as hazardous wastes under RCRA are those waste streams sent to publicly owned treatment works (POTW's)[1] and waste streams mixed with domestic sewage [see 40 CFR §261.4(a)(1) and 40 CFR §265.1(c)(3)]. Other such excluded waste streams are listed specifically in the introduction to Section 4. The survey design specifically excluded such waste streams from the estimated quantities of hazardous waste generated in 1981.

More importantly, however, the survey design also excluded from its estimates quantities of RCRA-regulated hazardous wastes that were managed exclusively in processes exempted or excluded from regulation under RCRA. The most prevalent examples of such survey-excluded hazardous waste streams are those that were treated exclusively in wastewater treatment processes whose discharges are covered under NPDES permits and where the treatment occurred exclusively in tanks (as opposed to surface impoundments). Such tank treatment systems are excluded from regulation under RCRA, as detailed in EPA's November 17, 1980 Federal Register announcement (a copy of which is included in Appendix C), even though the waste streams treated therein may still be hazardous wastes as defined under RCRA.

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[1] POTW's are defined in Section 502(4) of the Clean Water Act.

The survey excluded such quantities of hazardous waste from its statistical estimates of 1981 hazardous waste generation due to an inability to properly measure such quantities at the management stage in the hazardous waste cycle. This inability results from the absence of a valid sample frame from which to select a sample of such processes for purposes of developing statistical data. Whereas owners and operators of RCRA-regulated hazardous waste treatment, storage, and disposal processes are required to file Part A permit applications indicating the presence of such processes at particular sites, owners and operators of excluded processes need not have submitted Part A applications. Without a valid sample frame, it is not possible to determine the number of such processes in operation or the quantities of hazardous waste that are managed exclusively in such processes. Some Part A applications were submitted for such processes, inadvertently, due to lack of information about the exclusions or because other processes at the site required submission of Part A applications and the excluded processes were included on the site's form, even though they were not required to be included. However, EPA has no way of determining the number of exempt processes for which Part A applications were not filed.

In order to preserve the integrity of the quantity estimates intended to be developed through the survey, all hazardous waste streams that were managed _exclusively_ in exempt or excluded processes were excluded from the survey, at both the management _and_ generation stages of the hazardous waste cycle. The reason for excluding such quantities from the generation estimates was that the survey was designed to produce comparable estimates of 1981 hazardous waste generation and its subsequent management (treatment, storage, and disposal). In designing the survey along these lines, OSW and Westat intended to observe essentially the same 1981 national hazardous waste stream in both the generation and management surveys; that is, it was intended that the TSD Facility Survey would account for and describe the management of all, or most, of the hazardous wastes estimated to have been generated in the Generator Survey.

These design criteria contributed to the design and structure of the survey questionnaires and samples. Limitations on the ability to collect quantity data at the management stage of the hazardous waste cycle also limited the nature and scope of the data that were requested at the point of generation. Since one of EPA's primary goals in conducting the survey was to estimate the impact of its regulatory standards on the regulated population, the survey was not designed to collect information about handlers, waste streams, or waste management activities that fall outside the scope of the RCRA regulatory program.

The decision rule for including hazardous wastes in the survey essentially stated that those wastes that did not encounter, or were not intended to encounter a RCRA-regulated hazardous waste treatment, storage, or disposal process were to be excluded from the survey's scope, while any hazardous wastes that were managed, at any point in the treatment, storage, and disposal cycle, in processes subject to regulation under RCRA, were to be included in the survey's scope. The following two examples help to clarify the impact of these restrictions on the survey estimates presented in the following sections.

Example A: Situation

> Firm A generated two million gallons of a corrosive wastewater stream during 1981. Since the pH of the stream was less than two, the wastewater stream would be considered a hazardous waste under RCRA. However, the firm employs a wastewater treatment system that consists entirely of a

series of tanks that neutralize the wastewater stream and remove other contaminants. The tanks' discharge into a nearby river is covered under an NPDES permit, and is therefore excluded from regulation under RCRA. The wastewater stream feeds directly into the NPDES tank treatment system and does not pass through any other treatment or storage process.

Quantities Included in Survey

Since none of the hazardous waste generated by Firm A passed through processes regulated under RCRA during 1981, none of the two million gallons generated would have been included in either the estimate of hazardous waste generation or the various estimates of hazardous waste management, including total hazardous waste managed, hazardous waste entering treatment, and hazardous wastes treated in tanks.[3]

Example B: Situation

Firm B generated a waste stream identical to that generated by Firm A. However, Firm B employs a wastewater treatment system that utilizes surface impoundments instead of tanks. Firm B's treatment system has an NPDES permit, but since the treatment occurs in surface impoundments, as opposed to tanks, the system is not eligible for the RCRA NPDES exemption.

Quantities Included in Survey

Since the hazardous wastes generated by Firm B passed through a treatment process regulated under RCRA during 1981, the entire hazardous waste stream generated by Firm B would have been included in the estimate of hazardous waste generation and in the various estimates of hazardous waste quantities managed in RCRA-regulated processes during 1981.

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[3] Generated quantities, in this case, could only be excluded using information from an associated Tank Questionnaire or supplied by respondents in marginal notes, waste stream descriptions, or telephone interviews during the data editing and cleaning process. For many generators, however, there was no way of knowing from the survey data that these quantities should be excluded.

EPA would have received a Notification form from Firm A indicating hazardous waste generation. As such, Firm A would have been eligible to be sampled as a generator. However, Firm A is not required to have submitted a Part A permit application to EPA indicating hazardous waste treatment, storage, or disposal. Therefore, it would not have been possible to survey Firm A as a TSD facility. Since generation and management activities were the foci of largely independent surveys, situations like these would have contributed to the estimates of hazardous waste generation while not contributing to the estimates of hazardous waste quantities managed, had the survey not been restricted as indicated. The result would have been incomparable estimates of hazardous waste generation and its subsequent management. Furthermore, since not all firms were aware of this exemption at the time they filed their Part A applications or even at the time they responded to the survey, the resulting estimates would have been based upon a mixture of regulated and nonregulated waste streams, leaving little or no clarity in the obtained data and substantially reducing the value of the derived estimates. By restricting the focus of the survey to those hazardous waste streams actually managed in processes regulated under RCRA during 1981, the survey yields valuable, clearly defined information about a specific aspect of the RCRA regulatory program, even though it purposely fails to answer other questions of interest.

Mixtures of Hazardous and Nonhazardous Wastes

The final issue requiring attention prior to the presentation of the survey's 1981 hazardous waste quantity estimates centers upon the impact of the RCRA "mixture rule" on those estimates. According to 40 CFR 261.3(a)(2)(ii), a solid waste (as defined in §261.2) is defined as a hazardous waste if it is a mixture of a solid waste (including "aqueous" solid wastes) and one or more hazardous wastes (as listed in Subpart D of Part 261 and not excluded under §260.20 and §260.22). Further specifications to this rule are provided in §261.3. However, the essence of the rule is that nonhazardous waste material becomes hazardous waste when it is mixed with hazardous waste, and must be managed as such. The implication of this rule is that in some cases, initially small quantities of hazardous wastes can result in huge quantities of hazardous waste through their mixture with large volumes of nonhazardous wastes or substances. Examples of such occurrences were observed in the data obtained through the Generator Questionnaire, as well as in the survey of TSD facilities, including cases where trace quantities of specific listed hazardous wastes were mixed with large volume industrial process waters, resulting in very large volumes of hazardous waste generated.

Hazardous waste quantities reported by many, if not most, of the largest generators and facilities observed in the survey were affected significantly by the mixture rule. The mixing process, however, varied considerably from case to case, with the mixture occurring anywhere from deep within the industrial processes themselves through the storage and treatment process and up to the point of disposal. The survey questionnaires were not, however, designed to provide separate quantity data for the various portions of these mixtures (i.e., obtained data do not indicate percent solids, percent listed wastes, percent water, etc.). The RCRA regulations are clear, however, in their intent to require these mixtures to be managed as hazardous wastes. [Certain exceptions to the rule are provided in 40 CFR §261.3(a)(2)(iv).] It is therefore appropriate, in fact mandatory, that these quantities be included within the estimates of hazardous waste generation provided in the following sections. As indicated previously, however, respondent error in correctly reporting quantities affected by the mixture rule (both underreporting and overreporting) may not always have been detected during the coding process, and therefore contributes to the uncertainty surrounding the estimates of 1981 hazardous waste generation.

Another mixture issue affecting the TSD quantity estimates developed through the survey relates to the management of nonhazardous wastes as hazardous wastes in hazardous waste treatment, storage, and disposal processes. Since respondent error in reporting such quantities could not always be identified, a more precise label for the hazardous waste management quantity estimates presented in this section would be that of "wastes managed as hazardous wastes."

6. QUANTITIES OF HAZARDOUS WASTE GENERATED

The findings presented in this section of the report are designed to estimate the quantities of hazardous wastes generated in the U.S. by activities of generators that generated RCRA-regulated quantities of hazardous waste during 1981 and whose hazardous wastes were or were intended to be managed subsequently in treatment, storage, and disposal processes subject to regulation under RCRA. Section 4 of this report cites the definitions of RCRA-regulated hazardous waste generators, and further identifies those types of generators and those waste streams that have been specifically excluded or exempted from regulation under RCRA.

The introduction to this part of the report (Part III: Sections 6 and 7), describing specifically the impact of RCRA's complex rules and exemptions on the nature of these quantity estimates, should be read carefully in conjunction with any interpretation or use of the estimates presented in this section.

As noted in the introduction to Part III, sampling error was extremely large for quantity estimates derived from the Generator Questionnaire. The Generator Questionnaire's estimates were designed to serve as the basis for most, if not all, of the estimates presented in this section. The large sampling error resulted in extremely wide confidence intervals around the generation quantity estimates; confidence intervals were nearly two thirds larger than those surrounding similar estimates from the TSD General Questionnaire, which was designed to produce estimates describing the post-generation stages of the hazardous waste management cycle.

As a result of these very large confidence intervals, an alternate mechanism was developed to derive the survey's estimate of the total quantity of hazardous waste generated in 1981. This alternate mechanism, which draws upon data collected in both the Generator and TSD General Questionnaires, is described in detail in Section 6.1, below, in conjunction with the presentation of the estimate itself. It is important to note at this point, however, that this alternate mechanism could not be refined sufficiently to serve also as the basis for the additional estimates provided in this section. Accordingly, the estimates presented in Sections 6.2 through 6.6 continue to be based exclusively upon data obtained through the Generator Questionnaire, and are thus subject to substantially greater uncertainty than other quantity estimates presented elsewhere in this report. Further discussion of the relationship between these additional estimates and the estimate of total 1981 hazardous waste generation is presented at the end of Section 6.1, and should be referred to in conjunction with their interpretation and use.

As indicated above, the survey's estimate of the total quantity of hazardous waste generated during 1981 is presented in Section 6.1. The additional breakdowns of this estimate, corresponding, in part, to the breakdowns of the numbers of generators presented in Sections 4.1 through 4.5, are presented in Sections 6.2 through 6.6. Section 6.7 then concludes the summary of the survey's findings regarding 1981 hazardous waste generation with a discussion and assessment of the various factors contributing to potential increases and decreases in annual generation rates of hazardous wastes subject to regulation under Subtitle C of RCRA.

6.1 1981 Hazardous Waste Generation Estimates

Based upon the definitions specified in the introduction to Part III of this report and the survey results, an estimated 71 billion gallons (approximately 264 million metric tonnes) of RCRA-regulated hazardous waste were generated in the United States during 1981. Because of the wide variation in the quantities generated by individual generators and other factors mentioned in Section 3.3 and detailed below, this estimate is rather rough. A more precise statement of the statistical reliability of this estimate, based upon calculations of sampling error, would be that we are very confident (95% confident) that the true quantity of hazardous waste generated in 1981 was between 35.7 and 106.3 billion gallons. Despite this wide confidence interval, the results of the survey clearly indicate that there were significantly greater quantities of hazardous waste generated in 1981 than previously estimated.

Prior to discussing the statistical details surrounding this estimate, however, it is important to highlight the fact that this 71 billion gallon estimate differs considerably from the preliminary survey findings released by EPA on August 30, 1983. When the survey results were initially tabulated, the quantity of hazardous waste generated during 1981 was estimated to have been 40 billion gallons (approximately 150 million metric tonnes). Even at that time, however, EPA believed, and indicated in its public presentation of the preliminary findings, that the 40 billion gallon estimate had a greater likelihood to understate, rather than overstate, the actual quantity of hazardous waste generated in 1981. Two factors led to this belief:

1) Even though the ±79.7 percent confidence interval associated with the 40 billion gallon estimate indicated that the actual quantity generated in 1981 could have ranged from 8 billion to 72 billion

gallons, actual generation data in hand (without applying the statistical weighting factors) from the respondents to the Generator Questionnaire, when added to the quantities believed to have been generated by respondents to the TSD General Questionnaire that did not receive the Generator Questionnaire, substantially exceeded the lower bound of that confidence interval; and,

2) The estimate of the total quantity of hazardous waste managed by TSD facilities during 1981, derived from the TSD General Questionnaire, was substantially larger than the 40 billion gallon generation estimate, even though most of the facilities included in the TSD sample turned out to be located at the sites of hazardous waste generators.

Subsequent to the release of the preliminary findings, the 40 billion gallon estimate was revised as a result of editing to a still preliminary 42 billion gallon estimate. Further analysis of the data obtained through both the Generator Questionnaire and the TSD General Questionnaire, however, revealed that this 42 billion gallon estimate (that appeared in early drafts of this report) continued to substantially understate the actual quantity of hazardous waste generated. Accordingly, efforts were undertaken to develop an alternate mechanism for deriving the total quantity estimate. These efforts proved to be successful, and resulted in the production of the survey's final estimate of 71 billion gallons of hazardous waste generated in 1981.

Essentially, the difference between the survey's preliminary and final estimates rests in the fact that the survey's 42 billion gallon preliminary estimate was based exclusively upon data obtained from generators through the Generator Questionnaire, while the final estimate of 71 billion gallons presented in this report is derived through a combination of appropriately weighted data obtained through both the Generator and TSD General Questionnaires. The reasons behind the shift away from total reliance upon the Generator Questionnaire and the decision to utilize data obtained through the TSD General Questionnaire in estimating the total quantity of hazardous waste generated in 1981 are described in detail below.

The Generator Questionnaire was mailed to a randomly selected sample of RCRA regulated hazardous waste generators (see Section 2.3 and Appendix A). Each respondent to the Generator Questionnaire was asked to report the total quantity of hazardous waste generated during 1981. At the conclusion of the survey field period, responses from eligible respondents (RCRA-regulated hazardous waste generators) were entered into computer data files and assigned weights, based primarily upon their probability of being selected for the sample (nonresponse adjustments were also used to refine individual base weights, as detailed in Appendix A).

The 42 billion gallon preliminary estimate was then derived through a simple summation of the weighted responses (each respondent's generation quantity multiplied by its assigned weight). Identical procedures were used to derive all of the generator statistics presented in Section 4, as well as for all of the TSD facility statistics (characteristics and quantities) presented in Sections 5, 7, and 8 of this report (of course, the TSD facility statistics were derived from the TSD General Questionnaire and its associated process-specific component questionnaires, not from the Generator Questionnaire).

Had the quantities of hazardous waste generated by individual generators been approximately normally distributed, this procedure for estimating the total quantity generated by that population would have produced a reasonably reliable estimate, since the survey enjoyed an exceptionally high response rate, a large sample size was obtained (2,084 eligible respondents to the Generator Questionnaire), and a reasonably valid sample frame (EPA's Notification and Part A/Telephone Verification files) was used to select the statistical sample. As indicated in Section 3.3, however, the size measures for the populations of RCRA-regulated generators and TSD facilities were not found to be normally distributed. Rather, both populations were found to be highly skewed; so skewed, in fact, that nearly all of the total quantities of hazardous wastes generated and managed were accounted for by very small proportions of the respective populations (see Figures 3 and 4).

As a result of these highly skewed populations, and due to the fact that the survey samples were designed to provide more accurate characteristic data (for reasons described in Section 2.3), the survey's quantity estimates are subject to high degrees of sampling error, or statistical uncertainty. Accordingly, the survey's quantity estimates have much wider confidence intervals associated with them than do the survey's characteristic estimates (e.g., the estimated numbers of generators and facilities, etc.).

The quantity estimates derived from the Generator Questionnaire, however, are substantially more affected by the problem of sampling error than are similar quantity estimates derived from the TSD General Questionnaire. As indicated in Table 3, the ±79.7 percent confidence interval surrounding the Generator Questionnaire's 42 billion gallon preliminary generation estimate is 63.3 percent wider than the confidence interval surrounding the TSD General Questionnaire's estimate of the total quantity of hazardous waste managed by TSD facilities during 1981. Analyses of the factors responsible for the extremely high degree of sampling error associated with the quantity estimates derived from the Generator Questionnaire led to the development of the alternate approach for deriving the estimate of the total quantity of hazardous waste generated during 1981.

The generator survey's greater potential for understating the total amount of hazardous waste generated nationally, is a result of the fact that the generator survey sample included a smaller number of the more important larger generators. Due to the highly skewed size distribution found in the population of hazardous waste generators, inclusion of a greater proportion of the larger generators in the generator sample would have improved the generation estimate. The TSD facility sample did, however, include larger numbers of the important larger facilities. The occurrence of a greater number of larger sites in the TSD facility sample than in the generator sample is due to two factors:

1) Treatment, storage, and disposal facilities, for reasons related primarily to economies of scale, tend more frequently to be located at the sites of larger generators as opposed to smaller generators; and,

2) The generator sample was made up of far more generators that do not operate on-site TSD facilities than of generators that do operate on-site TSD facilities.

The composition of the generator sample generally reflected the characteristics of the generator population as a whole. As indicated in Section 2.3, both the generator and TSD process component samples were drawn using equal probability of selection (within strata) sampling techniques, rather than probability of selection proportionate to size (PPS) sampling techniques. PPS sampling, by sampling larger sites with a greater likelihood of selection than in an equal probability approach, tends to produce more accurate quantity estimates. PPS sampling could not be used in this survey, however, due to the absence of adequate size data at the time the samples were drawn. Thus, neither sample attempted to focus on the important larger generators and facilities. Under equal probability sampling, the resulting samples of eligible respondents tend to resemble, in their composition, the major distributional characteristics of the populations from which they were drawn.

Figure 18 illustrates the overlap that exists among the populations of generators that submitted RCRA Notification forms (approximately 55,000) and TSD facilities that submitted Part A permit applications (approximately 10,000 at the time the survey samples were drawn; see Section 5.1). While only a small proportion of the notifying generators indicated (through additional submission of Part A applications) that they operated on-site TSD facilities, most of the TSD facilities indicated on their Notification forms (Part A applicants are also required to file Notification forms) that they were located on the site of hazardous waste generators.

Equal probability sampling (within strata, see Appendix A) from the generator population resulted in Generator Questionnaires being sent to a sample composed of 10,667 generators without on-site TSD facilities, and 553 generators with on-site TSD facilities, as would have been generally expected given the distribution of the generator population as illustrated in Figure 18.

Similarly, as would also have been expected based upon the population overlap illustrated in Figure 18, most of the 2,599 facilities that received TSD General Questionnaires were located on the sites of hazardous waste generators. Only 553 of these recipients, however, also received the Generator Questionnaire, since only 553 Generator Questionnaires were sent to generators with on-site TSD facilities.

Figure 18

OVERLAP AMONG POPULATIONS OF GENERATORS AND TSD FACILITIES REGULATED UNDER SUBTITLE C OF RCRA

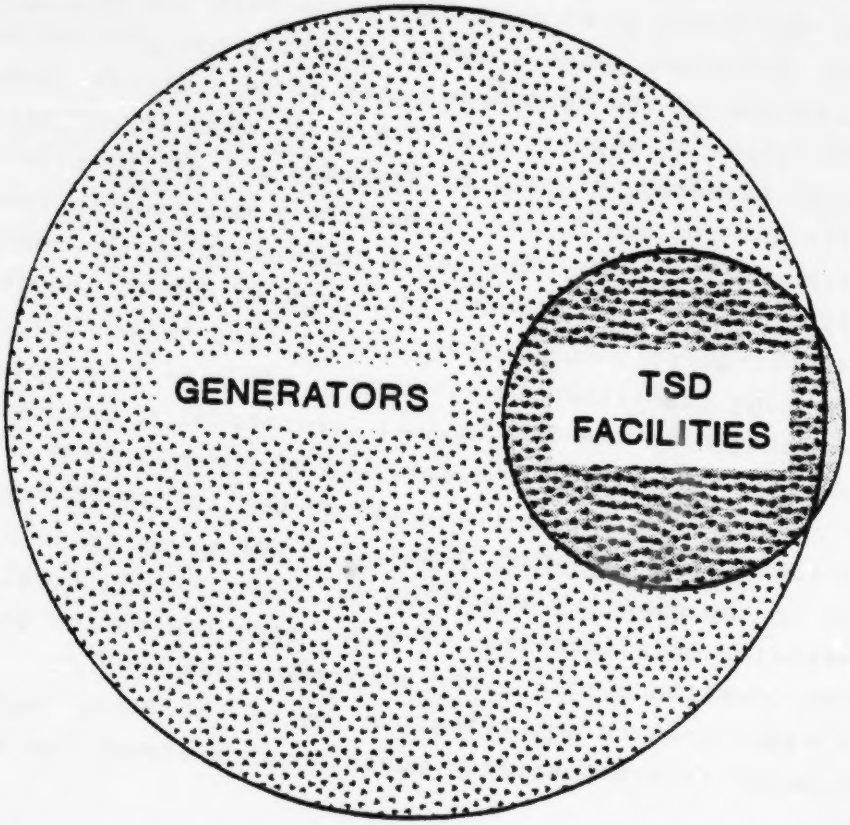

GENERATORS
TSD FACILITIES

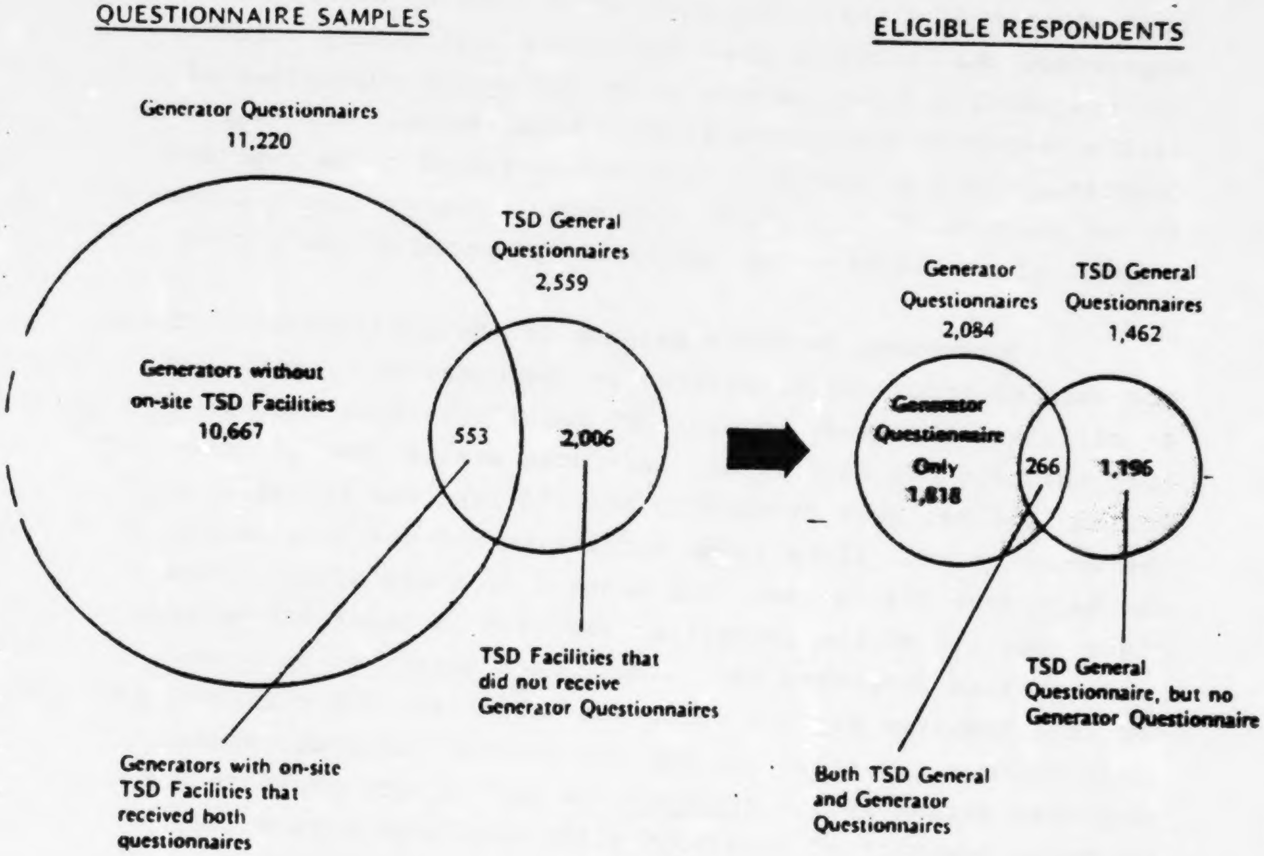
Figure 19 illustrates the overlap that occurred between the initial samples for the Generator and TSD General Questionnaires and the overlap between the eligible respondents to those questionnaires (whose responses serve as the basis for all of the estimates presented in this report).

The TSD General Questionnaire did not request facilities to indicate the quantity of hazardous waste that was generated at the site, since its purpose was to quantify the post-generation management stages of the hazardous waste cycle. It did, however, request facilities to report: (a) the total quantity of hazardous waste managed (treated, stored, or disposed of) at the site during 1981; and (b) quantities of hazardous wastes were received from off site during 1981. Through a comparison of the responses obtained from the 266 respondents that completed both the Generator and TSD General Questionnaires (see Figure 19), it was determined that subtracting quantities received from off site from total quantities managed in the TSD General Questionnaire produced a fairly reliable "proxy" for the quantity of hazardous waste generated at the site during 1981. Among the 266 sites completing both questionnaires, the proxy generation value was frequently equivalent to the quantity generated as reported specifically in the Generator Questionnaire. Furthermore, the sum of the TSD General Questionnaire's proxy generation values across the 266 sites came close to equalling the sum of the actual generation values reported in the Generator Questionnaire across the same 266 sites.

The proxy generation values were then computed for all respondents to the TSD General Questionnaire. In so doing, the survey obtained substantially greater numbers of "generator" observations since, as noted above, most of the sampled TSD facilities were located at the sites of hazardous waste generators. Initially, these observations were used only to calculate a

Figure 19

OVERLAP AMONG GENERATOR AND TSD SAMPLES AND AMONG ELIGIBLE RESPONDENTS


QUESTIONNAIRE SAMPLES
Generator Questionnaires
11,220
TSD General
Questionnaires
2,559
Generators without
on-site TSD Facilities
10,667
553
2,006
TSD Facilities that
did not receive
Generator Questionnaires
Generators with on-site
TSD Facilities that
received both
questionnaires
ELIGIBLE RESPONDENTS
Generator
Questionnaires
2,084
TSD General
Questionnaires
1,462
Generator
Questionnaire
Only
1,818
266
1,196
TSD General
Questionnaire, but no
Generator Questionnaire
Both TSD General
and Generator
Questionnaires

lower bound for the survey's preliminary estimate of the quantity of hazardous waste generated. This lower bound represented the minimum quantity of hazardous waste that was "known" to have been generated by the respondents to the survey alone, and approached the Generator Questionnaire's preliminary estimate for the total quantity generated by the entire population of 14,098 hazardous waste generators. Nevertheless, the Generator Questionnaire's preliminary estimate continued to be regarded as the only valid statistical estimate, although likely understated, of hazardous waste generation produced by the survey.

Subsequent to EPA's release of the preliminary findings, however, an error was discovered in the computer program used to calculate the lower bound. TSD facilities that indicated that they did not receive any hazardous wastes from off site during 1981 had been mistakenly omitted from the calculation of the lower bound. Since these facilities did not receive any of the hazardous wastes that they managed from off site, it was clear that all of the quantities reported in their TSD General Questionnaire responses had to have been generated on site. Once the computer program error was corrected, the recalculated lower bound - the known minimum quantity of hazardous waste generated during 1981 - exceeded the preliminary estimate for the total quantity of hazardous waste generated during 1981, necessitating the development of an alternate approach for deriving a reliable estimate for the total quantity generated.

The approach used in this report for estimating the total quantity of hazardous waste generated in 1981 was developed using some of the generation data obtained from the Generator Questionnaire and also using the TSD General Questionnaire's proxy generation indicator. The approach is logically consistent in its structure, takes advantage of additionally available "generator" observations, and has produced an estimate that is subject to substantially reduced statistical uncertainty over the preliminary estimate. Furthermore, the 71 billion gallon estimate derived using this approach compares closely with the estimate of the total quantity of hazardous waste managed in processes regulated under RCRA by TSD facilities during 1981 (see Section 7.1).

Essentially, the population of hazardous waste generators can be divided into two mutually exclusive populations:

- The population of generators that operate on-site hazardous waste treatment, storage, and disposal facilities; and
- The population of generators that do not operate on-site hazardous waste treatment, storage, and disposal facilities.

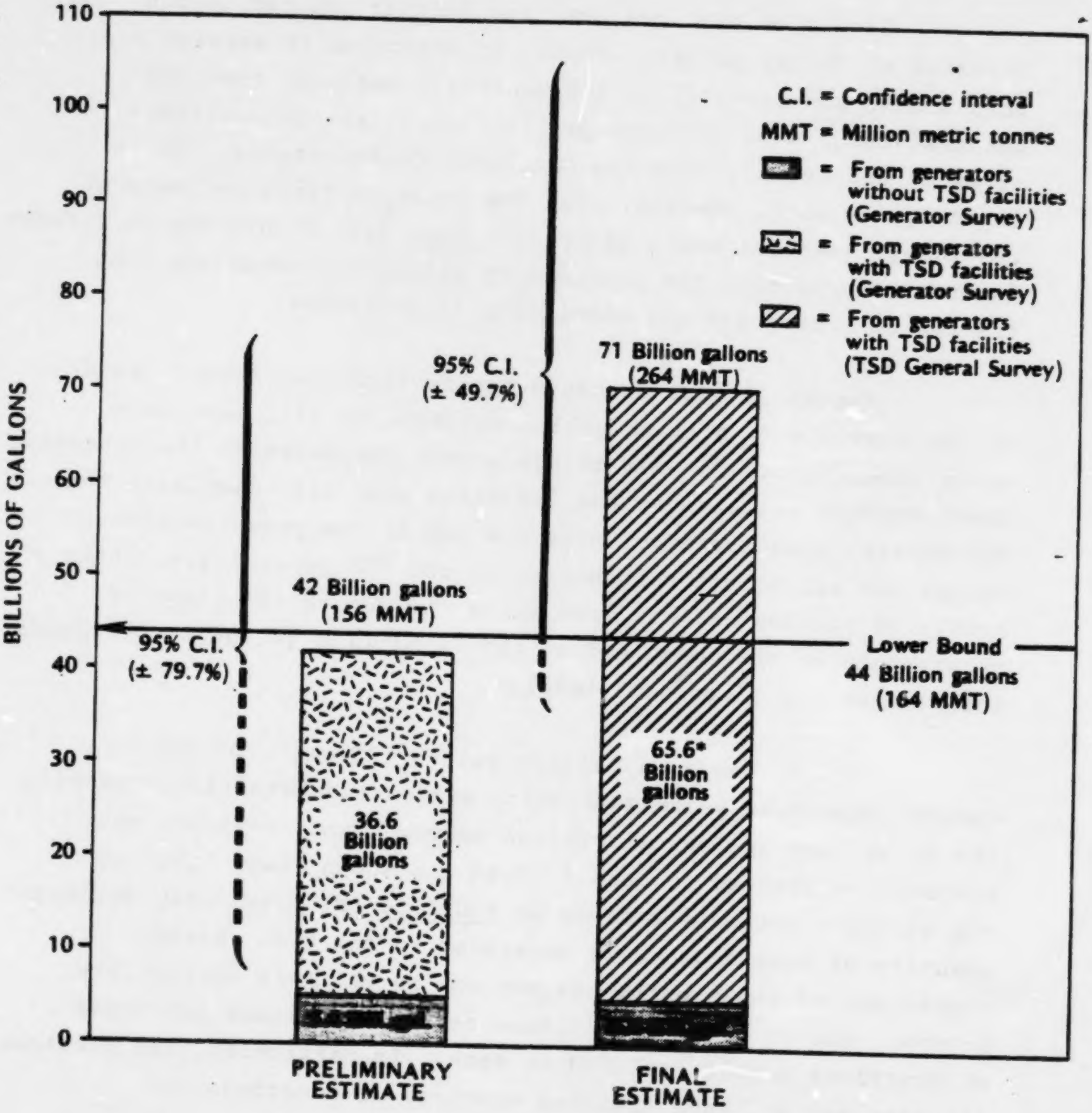
As indicated earlier in this section, RCRA-regulated treatment, storage, and disposal operations tend to be located more frequently at the sites of larger hazardous waste generators as opposed to smaller generators, primarily due to reasons related to economies of scale. Conversely, the larger hazardous waste generators tend to be included within the population of generators that operate on-site TSD facilities. Furthermore, the implication of the skewed size distribution found to characterize the population of hazardous waste generators is that omission or inclusion of a few of these large generators with on-site TSD facilities in a probability sample can significantly affect any quantity estimates derived therefrom.

The Generator Questionnaire, by not being targeted specifically at this important segment of the population, incurred excessive sampling error and related wide confidence intervals. The sample of 2,084 generators responding to the Generator Questionnaire contained only 266 generators that operated RCRA authorized TSD facilities on site. The TSD General Questionnaire, however, was targeted at this important group of generators, even though its intent was not to obtain information about generation itself. Of the 1,462 respondent facilities, 1,370 including the 266 sites included in the generator sample, were observed as generators of hazardous waste through the TSD General Questionnaire's proxy generation indicator.

The estimate of the total quantity of hazardous waste generated during 1981 is therefore best derived by adding together the independently obtained estimates of the quantities of hazardous waste generated by each of the two populations of generators. The Generator Questionnaire provides an estimate of 5.4 billion gallons of hazardous waste generated by the population of generators that do not operate RCRA authorized on-site TSD facilities. The TSD General Questionnaire provides an estimate of 65.6 billion gallons of hazardous waste generated by the population of generators that do operate on-site TSD facilities. Since these two populations are mutually exclusive, and since together they represent the entire population of hazardous waste generators regulated under RCRA, the survey's estimate of the total quantity of hazardous waste generated during 1981 can be obtained by adding these two estimates together for a total of 71 billion gallons generated, as indicated in the right hand bar (Final Estimate) in Figure 20. The left hand bar (Preliminary Estimate) is presented in Figure 20 for graphic comparison of the 42 billion and 71 billion gallon estimates, and to indicate how each division of the generator population can also be quantified exclusively using data obtained in the Generator Questionnaire. Note that the segments for generators without TSD facilities are identical in each estimate: both are derived from the Generator Questionnaire. This difference between the estimates rests entirely with the different generation estimates for generators with TSD facilities on-site. All indicators suggest that the TSD sample provides a better estimate for the quantity generated by this group.

Figure 20

ESTIMATES OF THE QUANTITY OF HAZARDOUS WASTE GENERATED IN1981



*Quantities generated were estimated by subtracting the amount recieved from off site from the amount managed, since the TSD General Questionnaire did not include a direct measure of generation.

Figure 20 also presents the statistical confidence interval at the 95 percent level. As indicated in Section 3.3, this confidence interval is substantially narrower than the interval associated with the preliminary generation estimate obtained exclusively from the Generator Questionnaire. It is important to note, however, that the survey's final estimate of the total hazardous waste generation does fall within the confidence interval surrounding the preliminary estimate, indicating that the two estimates are not completely inconsistent.

Figure 20 also presents the recalculated "lower bound" to the survey's 71 billion gallon estimate of 1981 hazardous waste generation. The sum of the actual responses to the Generator Questionnaire (except for the 266 sites that also completed the TSD General Questionnaire) plus the sum of the proxy generation values for all of the respondents to the TSD General Questionnaire equals 44 billion gallons, and serves to reduce the range of uncertainty at the lower end of the 71 billion gallon's confidence interval at the 95 percent level.

The survey's 71 billion gallon (264 million metric tonnes) hazardous waste generation estimate substantially exceeds the 11 billion gallon (41 million metric tonne) estimate most commonly referenced to date.[1] Even the known lower limit to the survey's estimate exceeds by fourfold the previously estimated quantity of hazardous waste generated in the U.S. Strict comparison of these estimates may not be entirely appropriate, however, due to potential differences in the nature and types of hazardous wastes included in each. In particular, the previous estimate may not have included mixtures of hazardous and nonhazardous wastes in the same way that such mixtures are included here. On the other hand, however, the 71 billion gallon estimate specifically excludes, wherever they could be identified, quantities of RCRA-regulated hazardous waste that were generated in 1981, but that were not, or were not intended to be, managed subsequently in processes regulated under RCRA (see the section on Exemptions and Exclusions in the introduction to Part III).

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[1] Booz Allen, Supra, p. III-6.

The major disadvantage of the alternate approach to estimating the total quantity of hazardous waste generated is that it could not be refined sufficiently to serve in a similar capacity for the other generation estimates presented in this section. An extensive attempt was made, for example, to develop a similar proxy value to identify the quantities of hazardous wastes that were shipped off site by TSD facilities during 1981. Respondents to the TSD General Questionnaire were not requested to report such shipments, and efforts to derive a proxy value did not meet with sufficient success when compared with answers by the 266 respondents to the Generator Questionnaire. Thus, the estimates presented in Sections 6.2 through 6.6 continue to be based exclusively upon data obtained through the Generator Questionnaire, and their absolute values, that are the basis of the percentages presented, are generally based upon the 42 billion gallon estimate derived from the Generator Questionnaire.

Accordingly, the estimates presented in the Sections 6.2 through 6.6 are presented in percentage form only. Implicit in this approach is the assumption that the breakdowns of the 71 billion gallon estimate follow the same distribution as do the breakdowns of the 42 billion gallon preliminary estimate. This assumption may not be appropriate in all cases. The remainder of the estimates presented in this section are, therefore, subject to greater statistical uncertainties than are other quantity estimates presented elsewhere in the report, and should be interpreted cautiously.

Finally, it is important to point out that, as indicated in Table 3, extremely narrow confidence intervals were obtained for nonquantity estimates derived from the Generator Questionnaire, and those estimates are unaffected by the issues affecting the quantity estimates. The survey sample was designed, for reasons discussed in Section 2.3, to produce accurate estimates of population characteristics. All available evidence suggests that it was highly successful in meeting that objective.

6.2 Size Distribution of Generators

As indicated in Section 3.3 and in Section 6.1, the population of hazardous waste generators was found to be highly skewed in terms of the quantities of hazardous waste generated by individual generators. A few very large generators are believed to account for ninety or more percent of the estimated 71 billion gallons of hazardous waste generated during 1981. Figures 3 and 4 in Section 3.3 graphically illustrate the similarly skewed distribution of the population of hazardous waste TSD facilities.

Graphic illustrations of the skewed distribution of the generator population, based upon the Generator Questionnaire, look very similar to the figures presented for TSD facilities. As indicated in Section 6.1, however, the Generator Questionnaire sample does not adequately represent the quantities of hazardous waste generated by the larger generators that operate on-site TSD facilities. Thus, graphic illustrations based exclusively on the Generator Questionnaire sample may not accurately represent the true size distribution of the generator population, and are therefore not presented in this report.

Nonetheless, it is clear, based upon the data obtained through the Generator and TSD General Questionnaires, that the size distribution of the population of hazardous waste generators regulated under RCRA is highly skewed. Furthermore, the survey's findings with respect to the highly skewed size distribution of the generator population are consistent with other studies conducted in individual states. The state of Massachusetts, for example, in its 1981 compilation of state hazardous waste reports, found an almost identical size distribution of generators in Massachusetts during 1981.[2]

6.3 Quantities Generated by Industry Type

Keeping in mind that a few large facilities in the sample dominate the generator quantity estimates (see the previous section) and that wide confidence intervals are associated with such data (see Section 4.2), this section will cautiously present estimates of quantities of hazardous waste generated by industry type. The estimates presented in this section are, however, based entirely upon the Generator Questionnaire, which understates the total quantity of hazardous waste estimated to have been generated during 1981 (see Section 6.1). The impact of that understatement is discussed below in relation to the industry estimates themselves. Since these quantity estimates are drawn from the Generator Questionnaire, however, the statistical uncertainty surrounding them is likely to be large (see Section 3.3). Their statistical uncertainty is increased even further since they represent subsets of that questionnaire's national estimates and are drawn from smaller sample sizes

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[2] Massachusetts Department of Environmental Management, Bureau of Solid Waste Disposal, Hazardous Waste Management in Massachusetts, Statewide Environmental Impact Report, August 1982, p. 14.

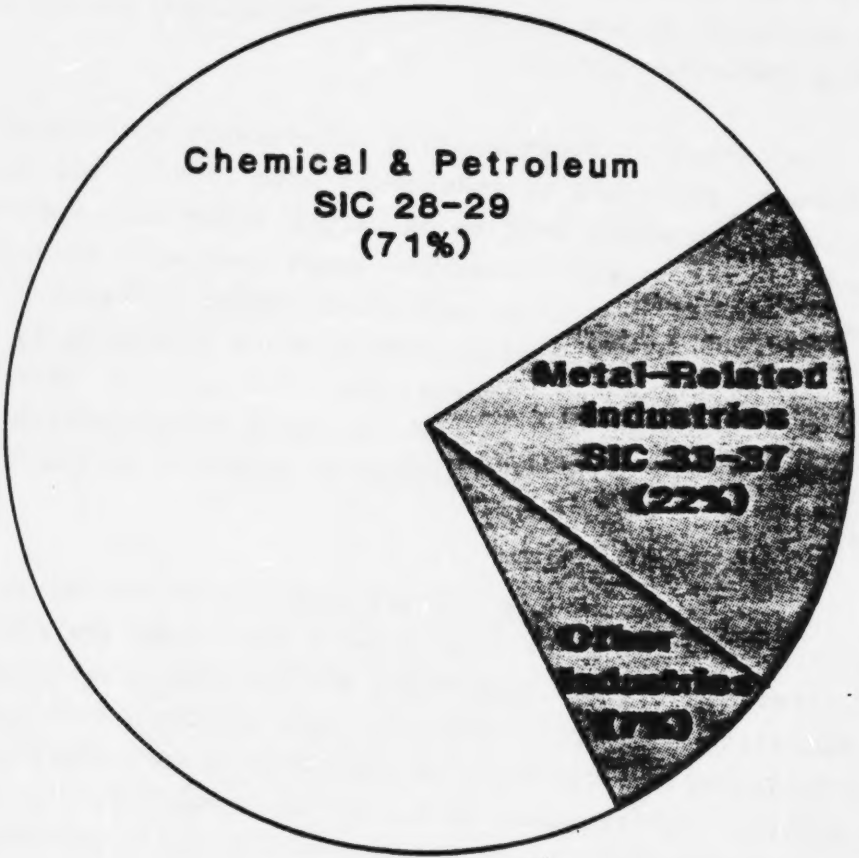
(requiring the application of the "K" factors) in determining their confidence intervals, as discussed in Section 3.3 and summarized in Table 5. For this reason it makes more sense to discuss larger subsets of the data rather than individual four-digit SIC codes that were collected in the survey.

Two industry groups that stand out are within the manufacturing sector (SIC 20-39). Manufacturing as a whole accounts for more than 90 percent of the total quantity of hazardous waste generated. As shown in Figure 21 the chemical and petroleum industries (SIC 28 and 29) alone account for more than 70 percent of total generation. This is almost entirely accounted for by SIC 28, the chemical industry. The average quantity of hazardous waste generated by chemical industry establishments (based on the Generator Survey) was almost four times larger than the average for all generators. This explains why the chemical industry, with only 17 percent of the generators, generated 68 percent of all the hazardous waste generated in 1981. The petroleum refining industry (SIC 29) accounts for about three percent of the hazardous waste generated in the U.S.

Another prominent group in the manufacturing sector was metal-related industries (SIC 33-37). The two largest hazardous waste generating industries of this group were Machinery, except Electrical (SIC 35), 10 percent; and Transportation Equipment (SIC 37), six percent. Together with Primary Metals (SIC 33), Fabricated Metal Products (SIC 34) and Electrical and Electronics Machinery Equipment and Supplies (SIC 36), these metal-related manufacturing industries generated approximately 22 percent of all hazardous waste generated in 1981.

Figure 21

QUANTITIES OF HAZARDOUS WASTE GENERATED IN 1981 BY INDUSTRY TYPE



All remaining manufacturing, nonmanufacturing, and industries not specified by kind accounted for about seven percent of U.S. hazardous waste generation. More than half of this was generated by the Motor Freight Transportation and Warehousing Industry (SIC 42).

The Generator Questionnaire understates quantities of hazardous waste generated by generators with on-site TSD facilities (see Section 6.1), which tend to be larger industrial operations. To the extent that larger industrial operations with on-site hazardous waste TSD facilities are concentrated in certain industries, the quantities of hazardous waste generated by those industries, and their proportions of total U.S. generation, are most likely understated by the Generator Questionnaire's estimates. Thus, proportions instead of quantity estimates are indicated in Figure 21.

As noted above, the average quantity generated by chemical industry plants is four times larger than the average for all other industries, suggesting a high concentration of larger operations and the likelihood that the Generator Questionnaire understates the quantity of hazardous waste generated in that industry. Furthermore, as indicated in Section 7.4 showing quantities of hazardous waste managed during 1981, the chemical and petroleum industries account for an even greater percentage (85%) of the total quantity managed. In particular, the petroleum industry, with only three percent of the generation total attributed to it, accounts for 19 percent of quantities managed. The comparisons suggest that the quantity of hazardous waste generated by the chemical and petroleum industries, and the proportion of total U.S. generation they account for, may be significantly understated in the Generator Questionnaire's estimates and in Figure 21.

6.4 Quantities of Hazardous Waste Generated by Type of Waste Group

One of the breakdowns of generated hazardous waste quantities most in demand is by waste group. Unfortunately, an analysis of results from the Generator and TSD General Questionnaires indicates that the study did not yield a conclusive estimate of the quantity of hazardous waste generated by waste type.

Low credibility in the waste group quantity breakdowns derived from the Generator Questionnaire was the result of many factors. First, respondents were asked to report the waste groups as percentages of their generation. Many respondents only roughly approximated these percentages. Second, statistical reliability of subpopulations of the quantity generated is likely to be lower than the already low statistical reliability of the Generator Questionnaire's estimate of the total quantity of hazardous waste generated, especially since there are many different waste groups, reducing the sample size from which the estimates are based (see Table 5 and discussion of "K" factors in Section 3.3). Third, the estimate of the quantity of hazardous waste generated derived from the generator survey is understated, thus understating the resulting quantities broken down by waste groups.

Of particular concern to this third factor is that the quantities of hazardous wastes generated by generators with on-site TSD facilities are those that are understated the most. Since these generators tend to be larger than those without TSD facilities, they may also exhibit different industry and waste group characteristics than the smaller facilities without their own management facilities. The sampling approach and skewed nature of the population combine to undermine the ability to accurately describe this important portion of the generator population. To the extent that these generators with on-site TSD facilities do generate various types of waste in proportions that differ from the proportions generated by other generators, the percentage breakdowns by waste group derived from the Generator Questionnaire may not accurately describe the "true" waste group composition of the total U.S. hazardous waste stream.

This concern is reinforced by the fourth, and final factor: the percentage breakdown by waste group for quantities generated, based on the Generator Questionnaire, differs substantially from the same breakdown for quantities managed based on the TSD General Questionnaire, as indicated graphically in Figure 22.

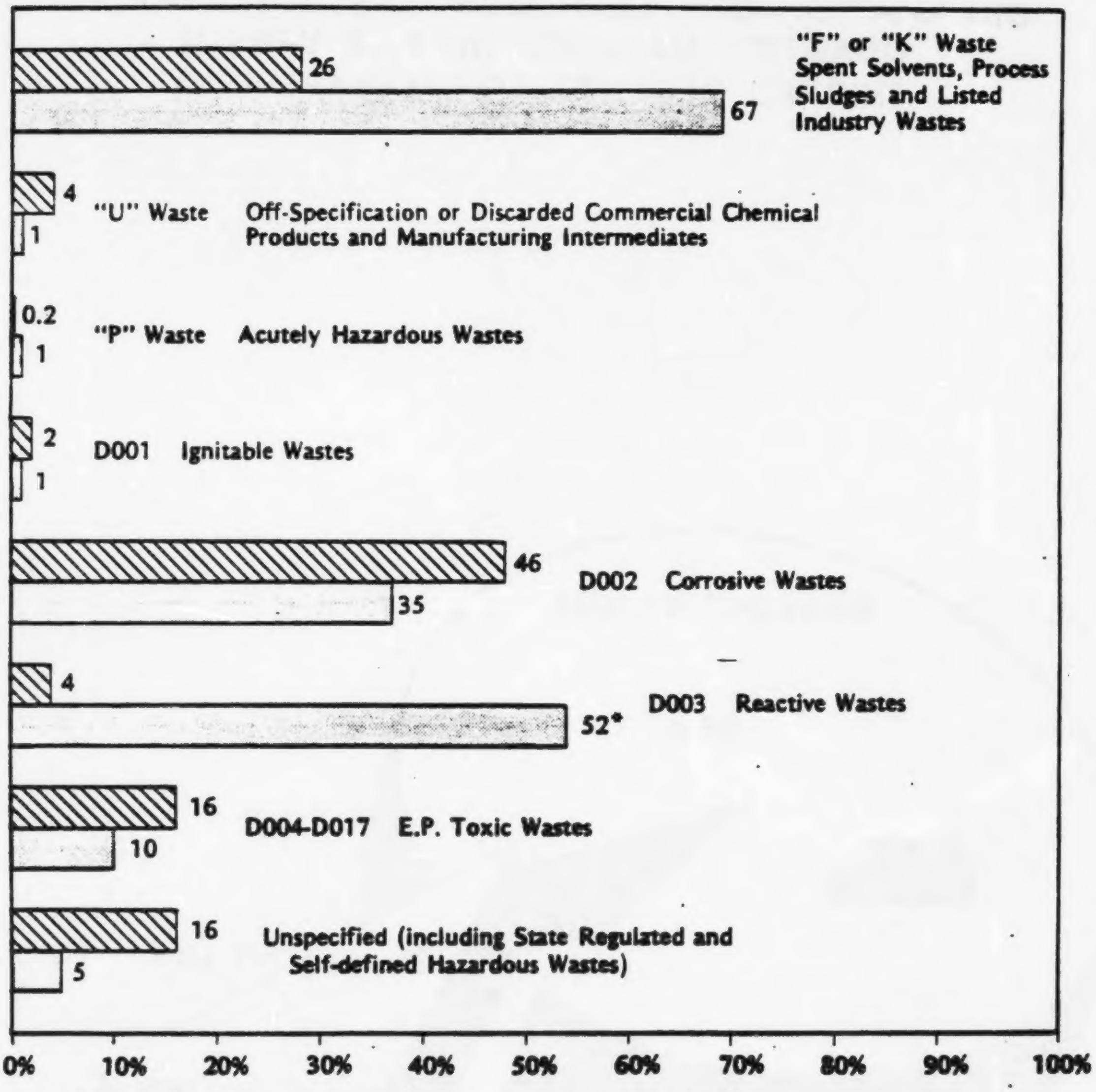
Although, for the reasons stated above, the Generator Questionnaire cannot be used as the basis for a breakdown of waste group quantities, the TSD General Survey also falls short as a standard, for reasons explained in Section 7.5. As a consequence, statements based on these surveys about quantities of hazardous waste generated (or managed) by waste group cannot be made with much precision.

6.5 Disposition of Quantities Generated: Managed On Site Versus Off Site

While the survey estimates that 84 percent of the 14,098 generators ship some or all of their hazardous wastes offsite (see Figure 9), the vast majority of the quantities of hazardous waste are managed onsite. Figure 23 presents the Generator Questionnaire's estimates of the proportions of generated hazardous wastes that are subsequently managed at on-site TSD facilities vs. the proportions shipped off site. Off site

Figure 22

WASTE GROUP PERCENTAGE COMPARISONS BETWEEN THE 1981 GENERATOR AND TSD GENERAL SURVEYS



*36 of the 52% is represented by one generator with a highly dilute waste stream

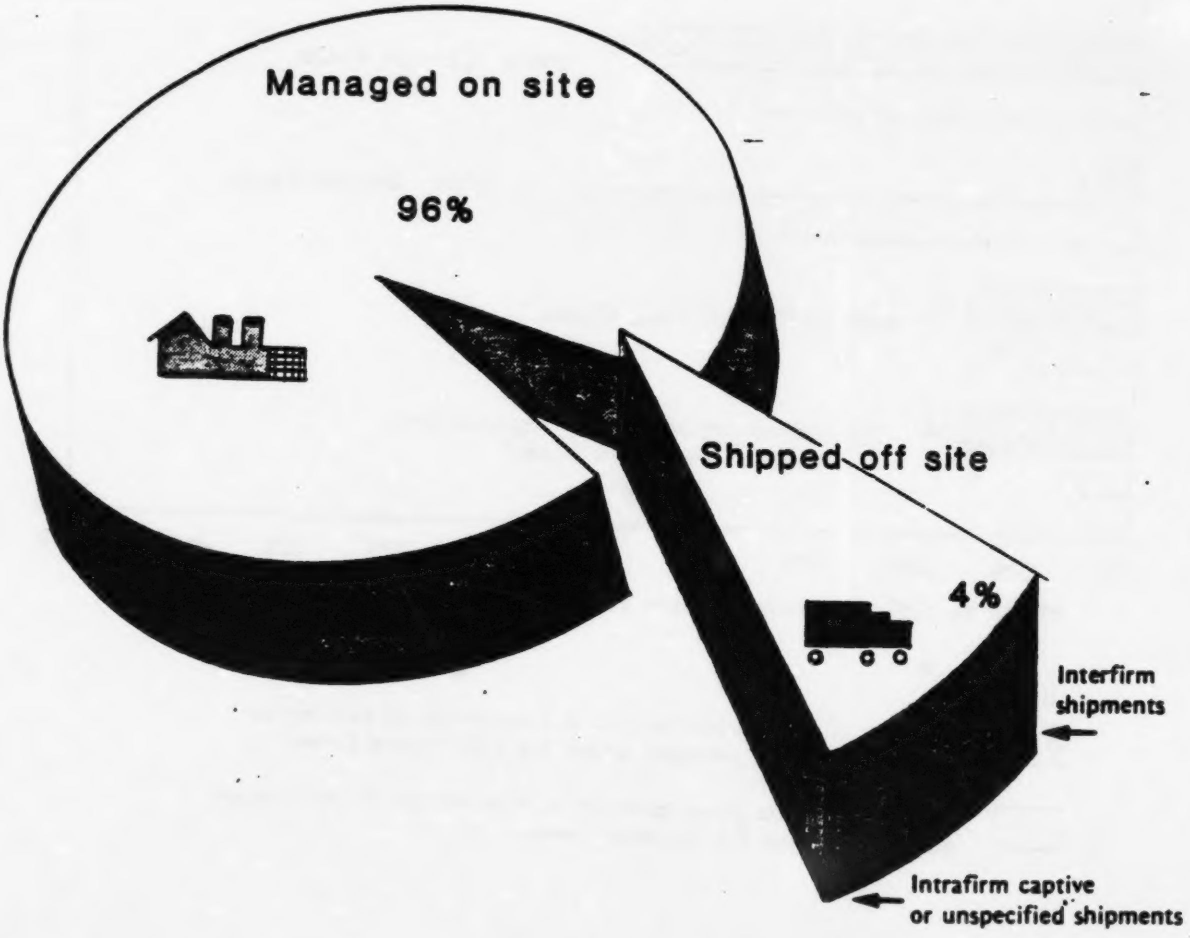
KEY

▨ Quantity of waste group handled as a percentage of total amount of all waste groups managed as per the TSD General Survey

☐ Quantity of waste group generated as a percentage of total amount generation, as per the Generator Survey

Figure 23

DISPOSITION OF HAZARDOUS WASTE GENERATED: QUANTITY MANAGED ON SITE VERSUS SHIPPED OFF SITE FOR MANAGEMENT



shipments are then further broken down between interfirm shipments (i.e., shipment by firms to facilities owned by other firms) and intrafirm shipments (i.e., shipments by firms to "captive" facilities that they own).

As indicated in the figure, data supplied by generators indicates that approximately 96 percent of all generated hazardous wastes are managed on site, with only four percent being shipped off site for treatment, storage, and disposal.[3] Interfirm shipments, which are assumed generally to represent "commercial" shipments, account for 82 percent of the total quantity shipped, with shipments by firms to their own captive facilities making up the remaining 18 percent of hazardous wastes shipped off site.

Although the dominance of on site vs. off site management of quantities of hazardous waste contrasts sharply with the comparison of the number of generators managing on site and the number shipping off site, the phenomenom is easily explained. Large generators manage their wastes on site because, among other factors, they experience economies of scale in constructing and operating on-site TSD facilities and because the costs of shipping and managing large quantities of hazardous waste off site are prohibitive. Economies of scale encourage generators of large quantities of hazardous waste to invest on site in high-volume waste management technologies that result in low unit costs for handling and disposal. Thus, one would expect to find greater quantities managed on site than shipped off site, even though the greater numbers of generators ship their hazardous wastes off site than manage them on site.

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[3] The on-site management portion may be even larger than the 96 percent indicated from the Generator Survey since that survey understates quantities generated by generators with on-site TSD facilities (see Section 6.1). Generators with on-site TSD facilities are less likely to ship their wastes off site. Were they adequately represented in the generator sample, their on site management practices would likely increase the estimate of the proportion managed on site and decrease the estimate of the proportion shipped off site.

This finding is also supported by the understanding of the distribution of hazardous waste generators across the size (quantity generated) spectrum. As previously discussed in Section 6.2, a few very large generators account for substantial portions of the total quantity of hazardous waste generated across the U.S., overwhelming the quantities of hazardous waste produced by the more numerous, smaller generators. Since these large generators are most apt, for reasons described above, to manage their wastes on site, it is not surprising that such quantities also overwhelm the quantities shipped off site for treatment, storage, or disposal by the many smaller generators.

The final point to be highlighted with respect to the information presented in Figure 23 relates to comparisons between the results produced by this mail survey and estimates published previously from other studies. In order to make such comparisons, however, the proportions presented in Figure 23 need to be translated into estimates of the actual quantities of hazardous wastes shipped off site and managed on site during 1981. As noted at the end of Section 6.1, quantity estimates have been withheld in favor of the presentation of proportions throughout this section because the Generator Questionnaire understates the estimate of the total quantity of hazardous waste generated during 1981. While the Generator Questionnaire produces an estimate of 42 billion gallons, this report estimates that there were actually 71 billion gallons of hazardous waste generated in 1981 (see Section 6.1). Thus, quantity estimates from the Generator Questionnaire could only be presented as proportions, since their actual values are inconsistent with the survey's 71 billion gallon estimate. A decision was also made to not apply the Generator Questionnaire's proportion estimates to the 71 billion gallon estimate throughout this section, due to uncertainties about the representativeness of those proportions (the Generator Questionnaire understates the quantities generated by large generators with on-site TSD facilities).

For purposes of the comparisons to be made in this section, however, the proportions derived from the Generator Questionnaire (as presented in Figure 23) will be applied to the 71 billion gallon estimate to derive estimates of the actual quantities needed to make such comparisons. Specifically, this process produces an estimate of 2.8 billion gallons of hazardous waste shipped off site during 1981, of which 2.3 billion gallons were shipped commercially (i.e., interfirm shipments) and approximately one half of a billion gallons were shipped by firms to their own captive TSD facilities (i.e., intrafirm shipments).

While the survey's estimate of 71 billion gallons of hazardous waste generated during 1981 is approximately six times greater than the most frequently referenced previous estimate (published in the Booz-Allen report),[4] its 2.3 billion gallon estimate of quantities shipped to commercial facilities is actually very similar to the Booz-Allen estimate of 1.9 billion gallons (7.2 million metric tonnes), of hazardous waste managed by commercial facilities.[5] Furthermore, the difference between these two estimates can be traced in part to the somewhat broader range of facilities included in the survey's definition of commercial facilities (see Section 5.3). Further accommodation of the difference between the two estimates is found in the fact that the survey's 2.3 billion gallon estimate may somewhat overstate the actual quantity of hazardous waste shipped to commercial facilities, due to the fact that the proportion estimate from which it is derived may itself be slightly overstated (see footnote 3).

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[4] Booz-Allen, Supra, p. III-6: Exhibit III-4, col. 5 total.

[5] Booz-Allen, p. V-20.

The high comparability between these separate estimates speaks well of each study's efforts to quantify commercial hazardous waste activities. At the same time, however, the substantial difference between their estimates of the total quantity of hazardous waste generated reaffirms doubts concerning the scope of most previous hazardous waste studies. In the past, most attention has been paid to off site shipments and, particularly, to quantities of hazardous waste shipped to commercial facilities. As a result, good estimates appear to have been generated by these studies concerning the characteristics and magnitudes of this subset of the population, but few insights were gained concerning similar data, particularly quantity data, for on-site hazardous waste management and the population as a whole. The major differences between the conclusions of this and earlier studies appear to be related to the previously unobserved activities of large hazardous waste generators with on-site TSD facilities.

6.6 Recycling of Quantities Generated by Location of Recycling Facilities

Despite the relatively large proportion (over 40%) of RCRA-regulated generators that indicated that they generated hazardous wastes that were recycled during 1981, only four percent of the hazardous wastes generated in 1981 were recycled.[6] It should be noted, however, that generators of certain hazardous wastes that recycle 100 percent of these wastes are not RCRA-regulated. Thus, they are not included in the estimates cited here. These results suggest that while many generators recycle, they tend to recycle only small portions of their hazardous waste streams. Over 80 percent of this recycling was done on site. Less than one percent of the off site shipments went to captive (owned by the generator) facilities; the remainder went to commercial recyclers. The average amount sent off site for recycling was substantially smaller than the average amount recycled on site. Figure 24 displays graphically the proportions of RCRA-regulated hazardous waste that were recycled in 1981.

Direct comparisons of the survey's estimates of quantities of hazardous wastes recycled with total quantities generated may be somewhat misleading. As stated in the introduction to Part III of this report, significant portions of the quantities included in the generation estimate are mixtures of hazardous wastes with industrial process waters (the resultant mixtures *are* hazardous wastes). Such mixtures are likely to reduce the

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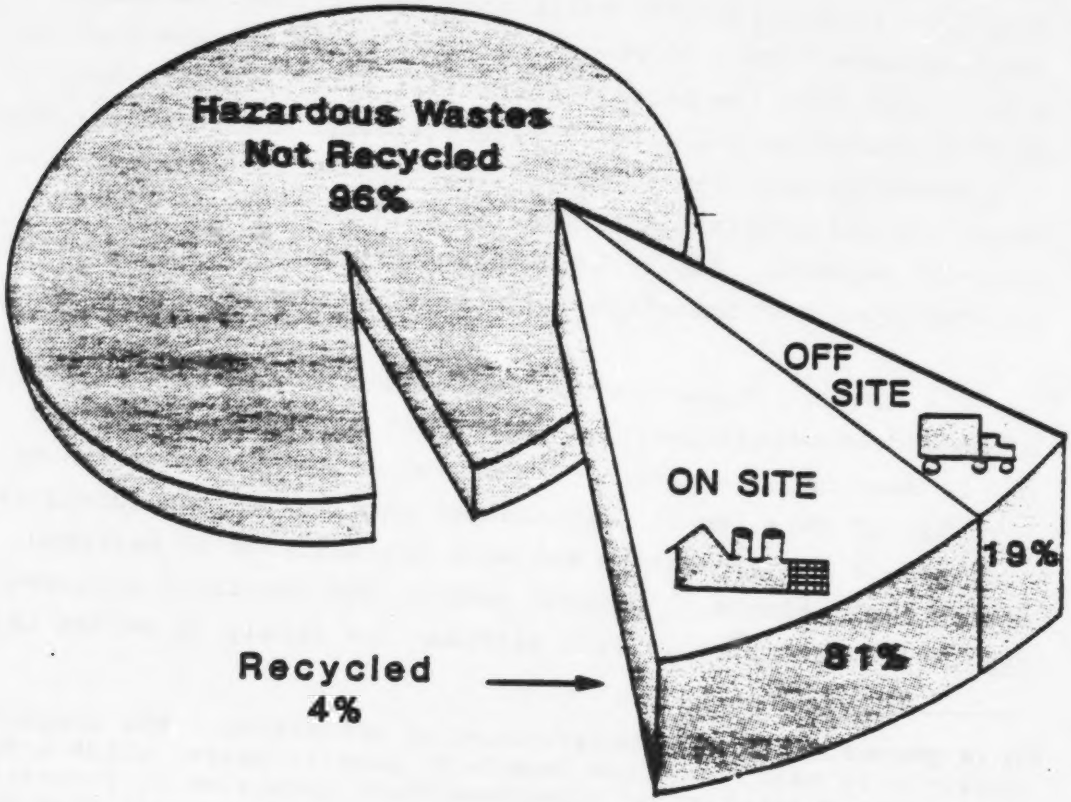
[6] This proportion may be understated or overstated. The proportion estimate is based upon the Generator Questionnaire, which understates the quantities of hazardous waste generated by generators with on-site TSD facilities. To the extent that these generators recycle greater proportions of their hazardous wastes than does the generator population as a whole, the proportion is understated. To the extent that these generators recycle smaller proportions of their hazardous waste, the proportion is overstated.

Figure 24

HAZARDOUS WASTES RECYCLED IN 1981
(% on site vs. off site)



feasibility of recycling, since the materials sought in the recycling process -- the hazardous constituents -- represent only a small portion of the total volumes. A more meaningful comparison would be between quantities recycled and quantities "recyclable" (i.e., the quantities of the hazardous constituents themselves). The survey data do not, however, disaggregate the quantities in such mixtures, preventing presentation of such comparisons in this report.

6.7 Future Hazardous Waste Generation Regulated Under RCRA

The survey was designed to establish estimates of the RCRA-regulated quantities of hazardous waste generated during 1981 and the quantities of hazardous waste managed in processes regulated under RCRA during 1981. Although quantitative data relating to anticipated future hazardous waste generation rates were not obtained through the survey, it is appropriate nonetheless to conclude this section of the report with a discussion of the factors that are likely to contribute to increases and/or decreases in the annual quantities of regulated hazardous waste generated in future years.

The quantity of RCRA-regulated hazardous wastes generated at any point in time is essentially affected by two factors:

- The specific nature and scope of the RCRA hazardous waste regulatory program at that time; and
- The nature of the industrial and other activities that actually result in hazardous by-products.

Currently, Congress is considering a number of statutory changes to RCRA. Some of these changes, upon enactment, would have a considerable effect on the range of activities covered under the RCRA regulatory program and, therefore, upon the quantities of RCRA-regulated hazardous waste generated in the future. Important among the statutory changes under consideration are proposals to reduce the "small quantity generator" definition for generators of hazardous waste. While firm estimates of the numbers of small quantity generators that would be affected by such a change are not yet available (see Section 9, Future Studies), it is assumed that thousands of currently exempt firms would be brought into the RCRA-regulated community under these provisions. Furthermore, while information is also not yet available to estimate the additional quantities of hazardous waste that would be regulated under RCRA as a result of such a provision, it seems clear that an increase in the size of the RCRA-regulated population will serve to increase the quantities of regulated hazardous waste generated in the future.

Other changes currently under consideration by the Congress and at EPA involve the removal of exemptions for wastes burned as fuels, and removal of certain exemptions covering recycling activities. All of these changes to the RCRA regulatory program would be expected to result in greater quantities of wastes regulated under RCRA in future year.

Implementation of industrial pretreatment standards by EPA and States may also affect future hazardous waste generation. Currently, an unestimable quantity of otherwise hazardous wastes are exempted from regulation under RCRA because they pass legally through public sewer systems into Publicly Owned Treatment Works (POTW's). While the quantities of such wastes cannot be estimated by this survey, information from other sources suggests that such quantities are indeed large. The Massachusetts Bureau of Solid Waste Disposal, for example, estimates that the quantity of hazardous waste generated annually in Massachusetts could increase by more than 50 percent with the implementation of pretreatment standards and the installation of industrial pretreatment processes by currently exempt generators.[7] Similar experiences in other States would add considerably to the quantities of hazardous waste regulated under RCRA in future years.

Increased industrial output, prompted by improved economic conditions, could also serve to increase hazardous waste generation in future years. The 1981 national economy was in an economic slump, resulting in reduced industrial output. The survey was not able to determine the relationship between changes in the levels of industrial production and changes in the quantities of hazardous waste generation. However, it is generally believed that there exists a direct relationship between these two factors. Thus, hazardous waste generation would be expected to increase during periods of improved economic conditions.

EPA is currently proposing the listing of additional wastes as hazardous wastes. To the extent that such listings, now and in the future, are actually promulgated, the quantities of hazardous waste regulated under RCRA are expected to increase accordingly.

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[7] Hazardous Waste Management in Massachusetts, pp 7-13.

Finally, increased clean-up of abandoned or closed hazardous waste sites will generate additional quantities of hazardous waste that require proper disposal under RCRA. The survey observed some such quantities being generated during the 1981 calendar year. Implementation of the "Superfund" program by EPA and States has advanced since 1981 and is expected to continue to advance in coming years, with resulting increases in the quantities of hazardous waste to be managed.

While the factors stated above are among the factors that are expected to result in increases in hazardous waste generation in future years, a number of other factors are expected to contribute to decreases in future hazardous waste generation. Prominent among these are proposals in Congress and some States to adopt specific taxes on the generation and/or disposal of hazardous waste. These taxes are often intended, among other things, to provide economic disincentives toward the actual generation of hazardous waste. These and other existing or future economic factors are expected to encourage industries to engage in greater "source reduction" and "source separation" to eliminate or reduce their generation of hazardous waste.

Further regulatory actions by the Congress and EPA that may encourage or require reductions in hazardous waste generation include proposed bans on the land disposal and underground injection of certain hazardous wastes. As disposal options for hazardous waste become more limited and more costly, generators will be encouraged to reduce their hazardous waste generation.

Finally, one of the purposes behind the enactment of the Resource Conservation and Recovery Act was to encourage the conservation of natural resources through the use, reuse, recycling, and reclamation of materials contained in industrial and other waste streams. As the value of natural resources increases, economic incentives for such recycling activities are expected to increase, resulting in increased efforts by generators to turn their waste streams into useful, valuable commodities.

It is difficult, if not impossible, to draw any firm conclusions concerning future hazardous waste generation rates based upon data available from the survey. The interactions of the factors described above, together with countless other factors not mentioned or even currently anticipated, are difficult to predict. Furthermore, the uncertainties surrounding this survey's 1981 generation estimates will make the measurement of any short-term changes in hazardous waste generation rates even more difficult to evaluate.

7. QUANTITIES OF HAZARDOUS WASTE MANAGED

The quantity estimates and breakdowns presented in this section pertain to a very specific population of hazardous waste management (TSD) facilities and hazardous waste management activities. The types of facilities and processes specifically included in the survey were defined in Section 5, notably including only those TSD facilities and those treatment, storage, and disposal processes that were subject to regulation under RCRA and that actively processed hazardous waste during 1981 (as opposed, for example, to having maintained a hazardous waste landfill without actually having entered new quantities of hazardous waste therein during 1981).

The introduction to this part of the report (Part III: Sections 6 and 7), describing specifically the impact of RCRA's complex rules and exemptions on the nature of these quantity estimates, should be read carefully in conjunction with any interpretation or use of the estimates presented in this section.

The quantity estimates presented in this section were developed from questions included in the Treatment, Storage, and Disposal General Questionnaire, and six of the eight technology-specific management questionnaires. Estimates of total quantities of hazardous waste managed, total quantities treated, stored, and disposed of at facilities, and estimates of quantities managed in waste piles, incinerators, and miscellaneous processes (not specified by kind, or not elsewhere classified), were estimated from the TSD General Questionnaire results, as were other facility-wide estimates. Estimates of the quantities of hazardous wastes managed in tanks, surface impoundments, containers, injection wells, landfills, and land application were based on the technology (component) questionnaires. All of the estimates presented pertain exclusively to 1981 calendar year operations.

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The latter stages of the hazardous waste management cycle, involving its treatment, storage, and eventual disposal, do not lend themselves to quantification in the same manner as the initial, or generation stage does. Whereas the "point of generation" (where measurements of hazardous waste quantities generated should be obtained) can be conceptualized and identified, a single corresponding "point of management" for such quantities frequently cannot be decided upon. Rather, generated hazardous wastes are frequently managed in multiple stages: initially stored after generation, then treated and/or disposed of. Accordingly, the decision as to the point at which the measurement, or quantification, of the management stage should take place is not as clear cut as in the case of generation.

In response to this problem, the TSD facility survey questionnaires obtained quantity information at various points in the management stages of the hazardous waste cycle. Initially, respondents were asked to identify the total quantity of hazardous wastes managed during 1981. Specifically, this question asked respondents to report the total quantity of hazardous waste that passed "through the front door" of the waste management facility (even if the facility was located on the site of generation), counting only once those quantities of hazardous waste that were managed in multiple stages. Thus, wastes that were initially stored or treated prior to disposal were to be counted at the moment that they entered such storage or treatment processes, and not to be counted a second, third, or fourth time upon their removal from such storage or treatment and their advancement to subsequent or final stages of processing. For generators that managed all generated hazardous wastes on site during 1981, it was expected that the quantity reported in response to this question would be equal to, or would approximate, the quantity of hazardous waste generated at that site during 1981.[1]

After obtaining in this manner the total quantity of hazardous waste managed during the calendar year, the questionnaires then went on to ask for quantity estimates corresponding to each individual stage of the hazardous waste management process, specifically calling for the repeated counting of quantities that were managed in multiple stages. Separate quantities were requested for hazardous wastes that were entered into storage, entered into treatment processes, and actually disposed of at the facility during 1981, without regard to any other management processes applied previously or subsequently to specific waste streams included in these quantities. It was expected, therefore, that the sum of these quantities (treatment plus storage plus disposal) would exceed the quantity of hazardous waste generated at a facility wherever wastes were managed in multiple stages or through multiple processes.

The estimates presented in the following sections should, therefore, be interpreted carefully. Subtle differences are built into each specific estimate, as each was developed to meet rather precisely defined information needs. Furthermore, due to the complex nature of the questions asked, it was not always possible to identify respondent errors in the obtained data, particularly with respect to the double counting or nondouble counting of waste quantities. While many such errors were detected and corrected in processing the survey responses, an unestimable number of respondent errors are believed to remain in the obtained TSD facility quantity data, despite the fact that extensive internal logic and consistency edit checks were designed into the questionnaires (see the survey field report contained in Appendix B). In the final analysis, many aspects of the management stage of the hazardous waste cycle lack the conceptual clarity and precision required to develop "hard" answers to questions that would appear, at first glance, to be simple and straightforward.

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[1] Subsequent analysis of responses from generators that completed both the Generator Questionnaire and the TSD General Questionnaire found a high correlation between total quantities reported generated and total quantities managed. Exceptions to this relationship were observed, however, and generally resulted in cases where generators managed hazardous waste in processes excluded from regulation under RCRA.

Estimates of hazardous waste quantities managed have been developed for the entire TSD facility population and for each of the subpopulations of facilities and specific waste management processes whose numbers and types were detailed in Sections 5 through 5.5. These survey estimates are presented in the following Sections 7.1 through 7.7. An analysis of hazardous waste treatment, storage, and disposal capacity estimates developed through the survey can be found in Section 8.

7.1 Quantity of Waste Managed as Hazardous by TSD Facilities in 1981

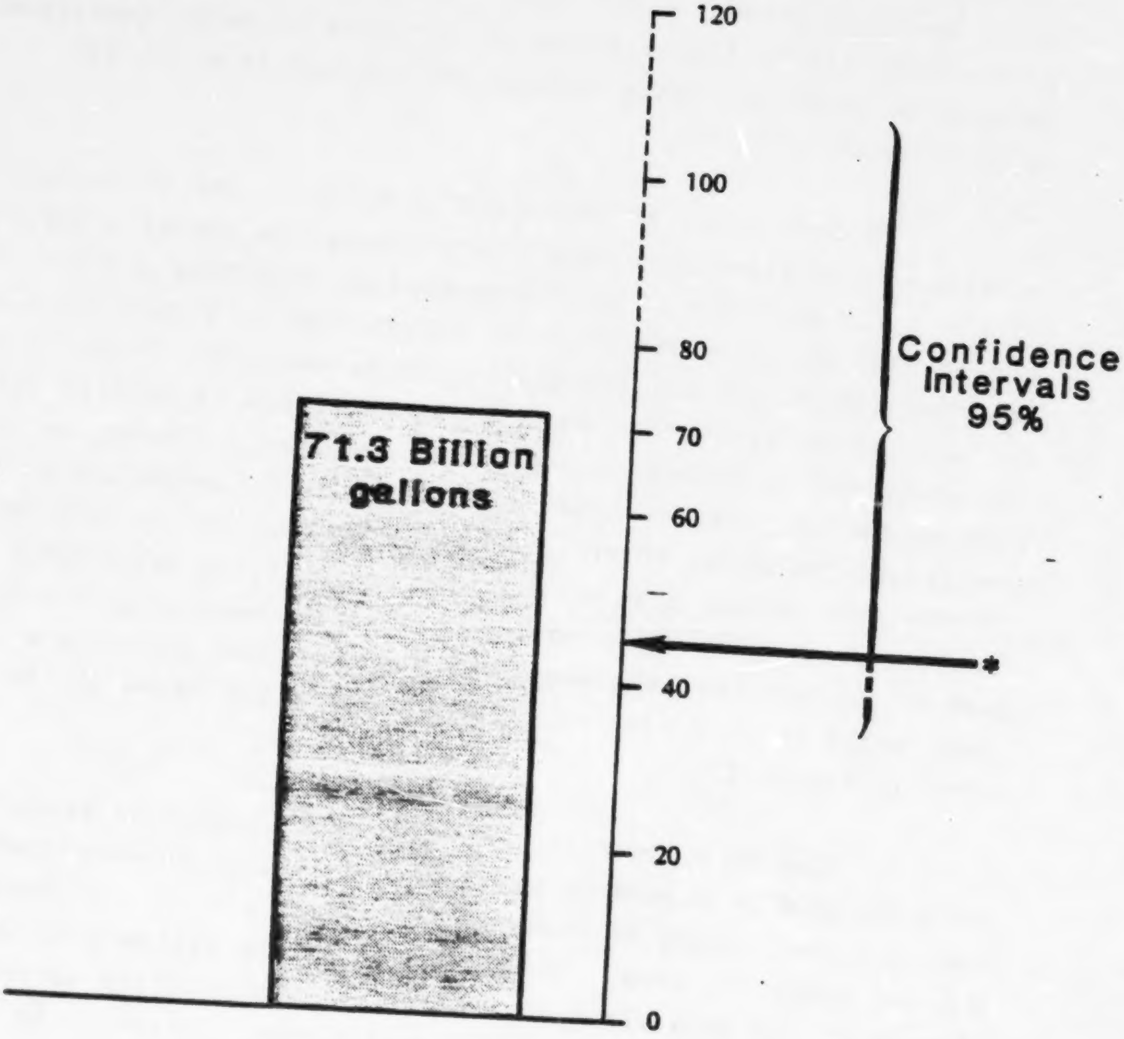
Based on survey results, the estimated quantity of waste managed as hazardous waste under RCRA in the United States in 1981 was 71.3 billion gallons (265 million metric tonnes). As in the case of generators, there exists a wide variation in the size of TSD facilities, with some facilities managing huge quantities of waste as hazardous waste (confirmed by independent EPA callbacks to Westat's largest respondents). However, as indicated in Section 6.1, since by definition it was targeted exclusively on sites with TSD facilities (most of which were also sites of hazardous waste generators), the TSD facility sample included substantially greater numbers and proportions of the important (in terms of the precision of derived quantity estimates) large quantity managers (and generators) than did the sample for the Generator Questionnaire. As indicated in Table 3, the 95 percent level statistical confidence interval surrounding the primary quantity estimate derived from the Generator Questionnaire was 63.3 percent wider than the confidence interval surrounding the 71.3 billion gallon estimate of total quantities managed as hazardous waste during 1981 derived from the TSD General Questionnaire.

Accordingly, as indicated in Table 3, the 95 percent statistical confidence interval surrounding the survey's estimate of the total quantity of wastes managed as hazardous wastes during 1981 is ±48.8 percent. As illustrated in Figure 25, this interval ranges ±36 billion gallons on either side of the 71.3 billion gallon estimate. However, as explained in Section 6.1, the lower end of this interval can be "bounded," thereby reducing some of the uncertainty about this estimate. A summation of the unweighted responses to the TSD General Questionnaire (adding together the actual answers provided by the 1,462 respondent facilities, without applying the statistical weighting factors used to project from the sample to the universe) produces a lower bound of 45.3 billion gallons, and is indicated by the arrow in Figure 25.

The survey's final estimate of 71.3 billion gallons of waste managed as hazardous waste during 1981 is somewhat reduced from the preliminary estimate of 80 billion gallons released by EPA on August 30, 1983. The reduction is due entirely to further editing of the data obtained through the TSD facility survey subsequent to the release of the preliminary findings. As indicated in the introduction to Part III of this report, the definition of hazardous wastes intended to be included in the national survey is fairly precise, requiring sophisticated evaluations of the responses to the survey questionnaires in order to identify and remove quantities of waste not intended to

Figure 25

QUANTITY OF WASTE MANAGED AS HAZARDOUS WASTES BY TSD FACILITIES IN 1981



71.3 Billion gallons = 265 Million metric tonnes

***Known lower limit on quantity managed**

be included under the survey's definitions. Most prominent among such wastes, as noted earlier, are those managed exclusively in processes not subject to regulation under RCRA. Subsequent to the August 30 release of the preliminary findings, additional methods were discovered for identifying such quantities, among others, in the obtained data. Application of those methods, in the form of a second round of computer edit and internal consistency checks, resulted in the reduction of the survey's management estimate from the preliminary figure of 80 billion gallons to the final estimate of 71.3 billion gallons presented in this report.

In addition to the statistical uncertainty ranges presented above, there are a number of nonsampling error sources whose effect and magnitude cannot be precisely estimated. These include: respondent error in reporting quantity; misunderstanding of RCRA-covered waste (especially wastewater, 90-day storage and mixture rule exclusions); possible respondent misunderstanding of storage and treatment as aggregate to date rather than 1981 additions (i.e., inclusion of stocks on hand carried over from previous years); and processing errors, (e.g., unit conversions, coding, keypunch). Many of these factors will be the subject of further study, especially the wastewater exclusions. The failure of some respondents to exclude exempted treatment tank wastewater in the TSD General Survey combined with an inability to identify such cases systematically, has resulted in an estimated overstatement of roughly 5 billion gallons in the total quantities treated. Such misreporting also affects the estimate of total quantities managed and all breakdowns of that quantity that are presented in Section 7.1 through 7.7.

7.2 Size Distribution of TSD Facilities

As indicated in Section 3.3, the distribution of quantity of hazardous waste managed is quite skewed. A few extremely large facilities dominate the measures from all others. The two largest sites sampled contribute 25 percent of the estimated total of 71 million gallons in the country. The sites representing the largest one percent in the country provide approximately 72 percent of the estimated national total. The largest two percent provide 87 percent of the total. Figure 26 illustrates the size distribution for management facilities in the country.

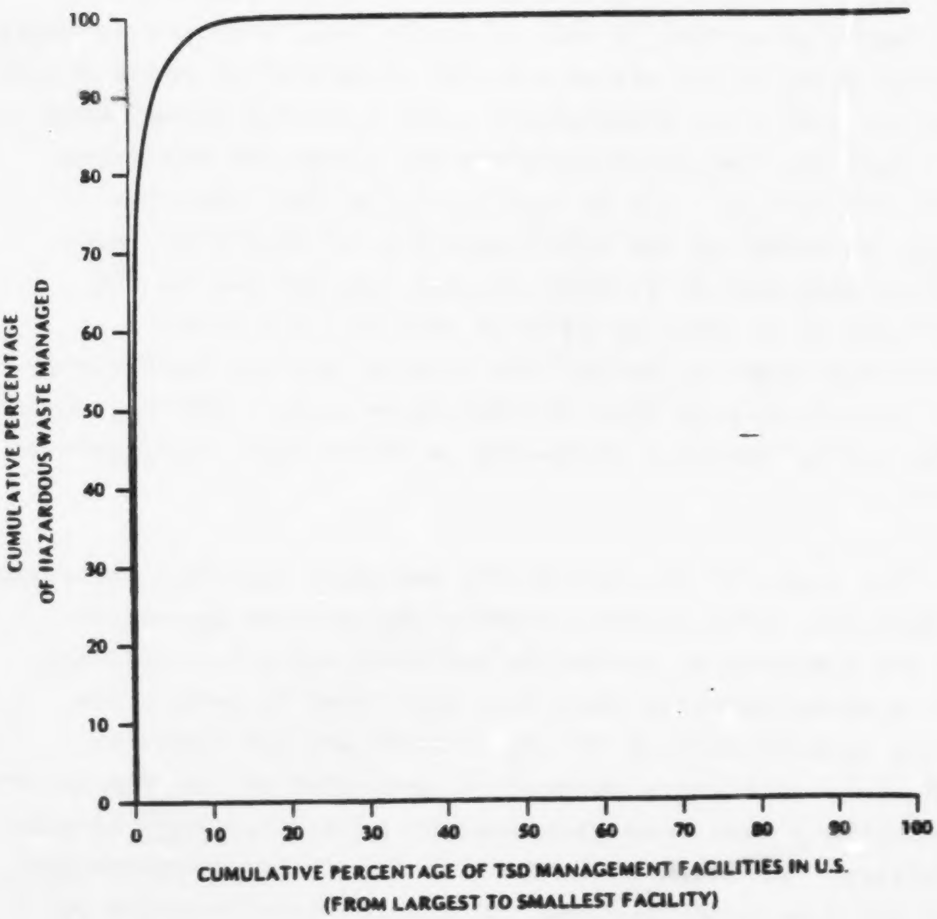
For future survey efforts desiring to obtain more precise estimates on total quantities managed nationally, prior identification and selection of the largest management facilities will improve the precision of quantity estimates. However, the identification of an appropriate, reliable size measure applicable to all or most facilities in the universe may require some investigation due to the fact that different size measures have greater applicability to some processes than to others (see Section 2.3).

7.3 Comparison of Quantities of Hazardous Waste Generated and Managed

As stated in the introduction to Part III of this report, the national survey was designed to produce comparable estimates of the 1981 hazardous waste generation and its subsequent management (treatment, storage, and disposal). In designing the survey along these lines, OSW and Westat intended to observe essentially the same national 1981 hazardous waste stream in both the generation and management surveys; that is, it was

Figure 26

COMPARISON OF CUMULATIVE DISTRIBUTIONS OF QUANTITY OF HAZARDOUS WASTE MANAGED IN 1981 AND THE NUMBER OF TSD FACILITIES



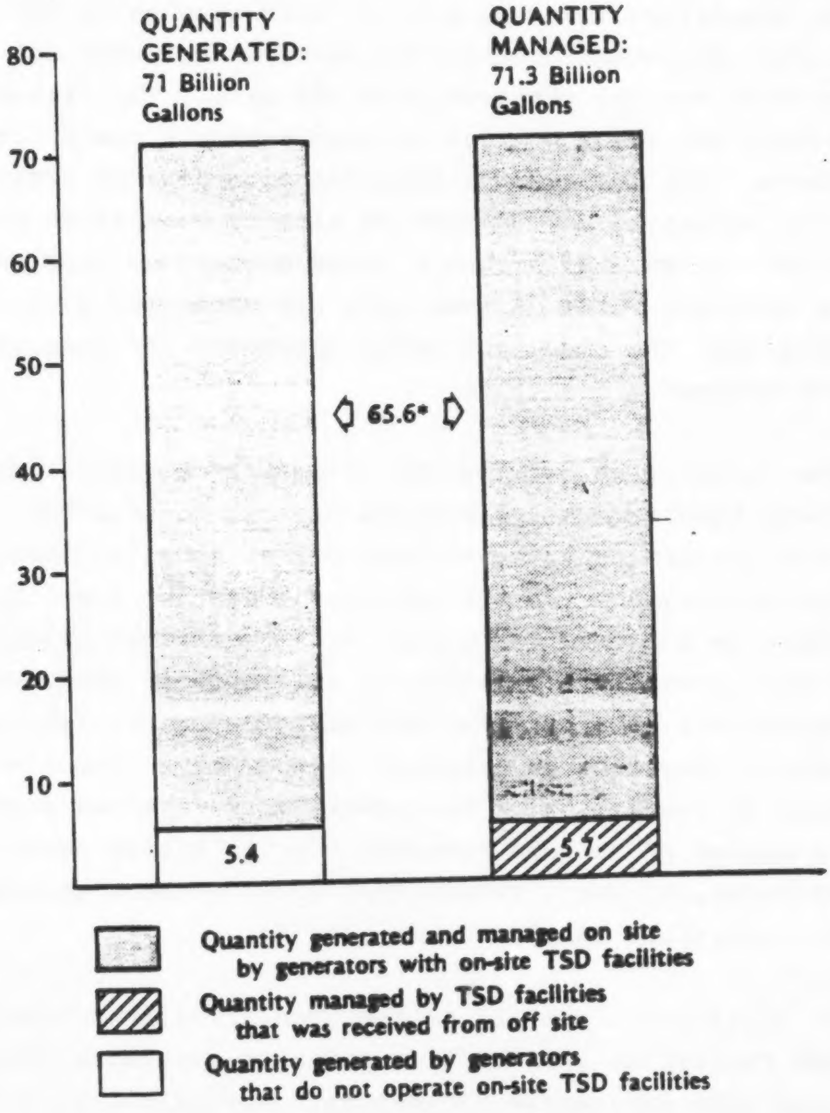
intended that the TSD facility survey would account for and describe the management of all, or most, of the hazardous waste estimated to have been generated in the generator survey.

In the final analysis, the survey design can be seen as largely successful in meeting this objective: as indicated in Figure 27, the survey's estimate of the total quantity of hazardous waste generated is only slightly less than its estimate of the total quantity of wastes managed as hazardous waste during 1981. At the time that preliminary results of the survey were released, however, the difference between these two estimates was fairly substantial, due primarily to the fact that the preliminary estimate of the total quantity of hazardous waste generated in 1981 was 40 billion gallons (as opposed to the final estimate of 71 billion gallons used in this report). Section 6.1 discusses in detail the reasons why the preliminary estimate, derived solely from the Generator Questionnaire, understated the actual quantity of hazardous waste that was generated during 1981.

The final 71 billion gallon estimate for 1981 hazardous waste generation, used in this report, was derived by adding together the quantity of hazardous waste estimated through the Generator Questionnaire to have been generated by generators that do not operate on-site TSD facilities and the quantity estimated, through a proxy generation indicator in the TSD General Questionnaire, to have been generated by generators with on-site TSD facilities. As detailed in Section 6.1, a proxy generation indicator was developed from the TSD General Questionnaire by subtracting the quantity each facility reported as having been received from off site (i.e., not generated on site) from the total quantity each reported managing during 1981. The logic supporting this calculation is that quantities of hazardous waste that were managed at a site and that were not received from off site must have been generated on site.

Figure 27

QUANTITY GENERATED VERSUS MANAGED



*Estimated from TSD General Questionnaire by subtracting quantities received from off site from total quantities of hazardous waste managed

Figure 27 presents the survey's estimates of the total quantity of hazardous waste generated during 1981 and the total quantity managed as hazardous waste in that year. Each estimate is broken into its component parts: for generation, quantities generated by generators (a) with and (b) without on-site TSD facilities; for management, quantities managed that were (a) generated on site and (b) received from off site. The figure illustrates that the major portion of each estimate comes from the same source: the TSD General Questionnaire-derived proxy for quantities generated and managed on site by generators with on-site TSD facilities. With such a large percentage (approximately 98%) of each estimate being derived from the same source, it is not surprising that the resultant total estimates for quantities generated and managed are similar.

The correlation between the estimates of quantities of hazardous waste generated by generators without on-site TSD facilities and quantities received from off site by TSD facilities deserves some discussion. On the surface, these two quantity estimates would be expected to be similar: generators without on-site TSD facilities must be shipping all of their generated hazardous wastes off site to RCRA-regulated TSD facilities; such quantities would therefore be expected to show up in reports by TSD facilities of quantities of hazardous waste received from off site. A number of factors revealed through closer examination of those estimates, however, reveal that these numbers should not, in fact, correlate as closely as they do.

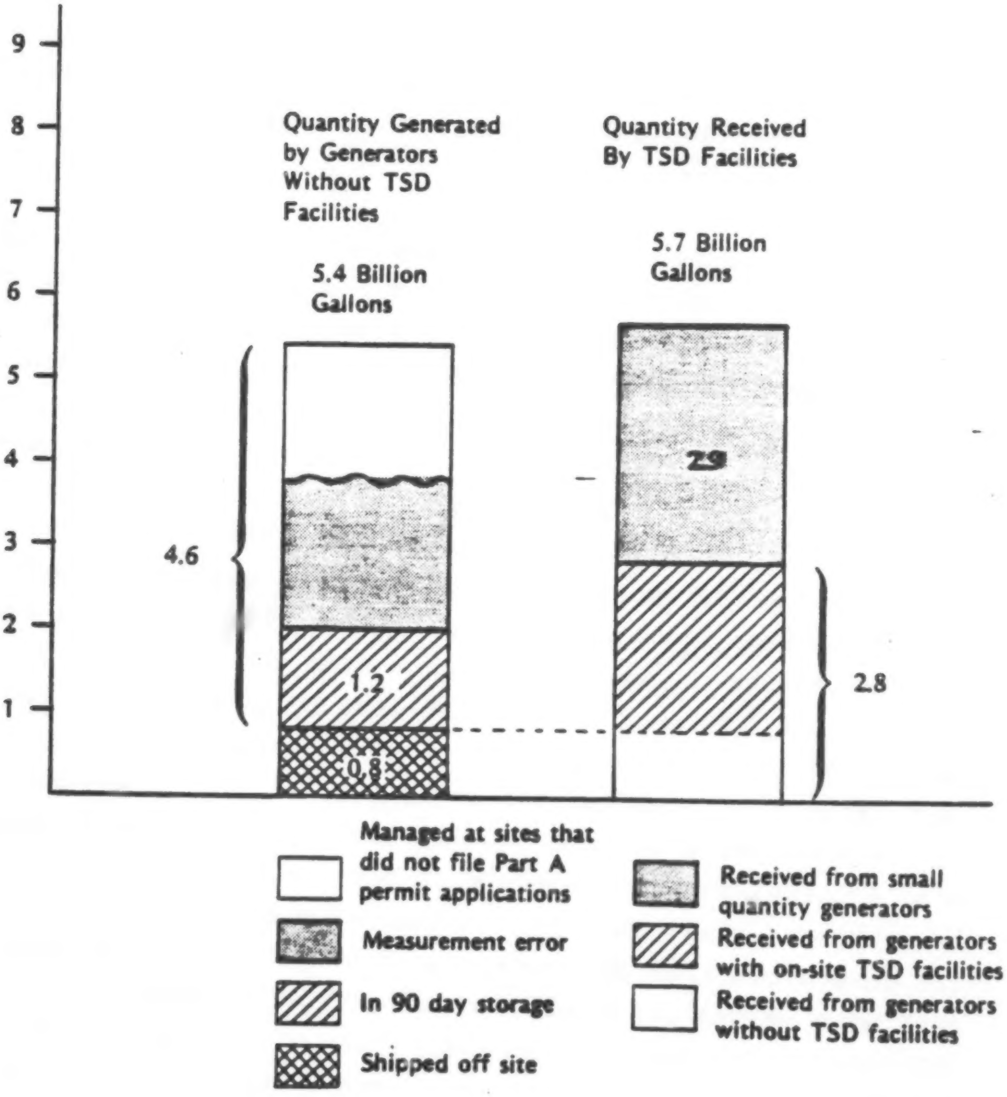
To begin with, not all of the quantities that RCRA-regulated TSD facilities receive from off site originate from RCRA-regulated hazardous waste generators. Specifically, 2.9 billion of the 5.7 billion gallons received by facilities from off site was indicated by them to have originated from small quantity generators that are not subject to regulation under

RCRA (see Section 4). Even though quantities received from small quantity generators are not, technically, RCRA-regulated hazardous wastes, they are included in the survey's estimates under the term "wastes managed as hazardous wastes" (see introduction to Section 7). Thus, the TSD facilities actually reported receiving only 2.8 billion gallons (5.7 billion - 2.9 billion = 2.8 billion gallons) of hazardous waste from RCRA-regulated generators. This 2.8 billion gallon figure, derived from the TSD General Questionnaire, correlates exactly with the quantity estimated in Section 6.5 to have been shipped off site by RCRA-regulated generators.

Figure 28 presents the estimates of quantities generated by generators without TSD facilities and quantities received from off site by TSD facilities in greater scale and more detail. The right hand bar in the figure illustrates the breakdown of the quantities received by TSD facilities between those originating from RCRA-regulated generators (2.8 billion) and those received from generators not regulated under RCRA (i.e., small quantity generators). The 2.8 billion gallons is then broken down further between estimated quantities received from generators with TSD facilities and generators without TSD facilities. This further breakout is based upon the estimate from the Generator Questionnaire of the quantity shipped off site by generators without TSD facilities (800 million gallons). The remaining 2 billion gallons that facilities reported receiving (2.8 billion - 800 million = 2.0 billion gallons) from RCRA-regulated generators is assumed to originate from generators with on-site TSD facilities who, nonetheless, still ship some hazardous wastes off site. Many of the generators that do operate on-site TSD facilities also ship hazardous wastes off site to other TSD facilities. Many of the TSD facilities that are located on the site of generators are actually only storage facilities (see Section 5.4). These generators store their wastes for more than 90 days, and as such

Figure 28

DESCRIPTION OF QUANTITIES GENERATED BY GENERATORS WITHOUT TSD FACILITIES AND QUANTITIES RECEIVED FROM OFF SITE BY TSD FACILITIES



appear as TSD facilities, then ship them off site for treatment or disposal. Additional generators with on-site treatment or disposal facilities also frequently ship residues from those processes to other facilities for final disposition.

The left hand bar in Figure 28 breaks out the estimated quantity of hazardous waste generated by generators without TSD facilities. The dotted line connecting the two bars indicates that the 800 million gallons shipped off site by these generators is assumed to account for 800 million gallons of the 2.8 billion gallons estimated to have been received by TSD facilities. This is only an assumption, however, since data collected from facilities are not broken to this degree.

Logic suggests that generators without RCRA-authorized TSD facilities must ship all of their generated hazardous wastes off site. As indicated above, however, this group of generators only reported shipping 800 million gallons of hazardous waste off site during 1981. The final disposition of the remaining 4.6 billion gallons of hazardous waste generated by generators without TSD facilities cannot be determined from the survey results. Some portions of that quantity can be explained, however, and generally quantified.

To begin with, not all of the 4.6 billion gallons actually had to be shipped off site during 1981. The RCRA regulations allow storage of hazardous wastes in containers and tanks on site for up to 90 days without submission of Part A applications. Thus, any wastes generated during the last 90 days of 1981 need not have been shipped off site by the end of 1981, and therefore would not be included in the generator's reports of 1981 off site shipments. Assuming equal generation rates in each quarter of the calendar year, up to 25 percent of the 4.6 billion gallons (1.2 billion gallons) generated in 1981 could legitimately have not been shipped off site by the end of 1981 by generators that did not file Part A permit applications.

Two additional factors account for the remaining 3.4 billion gallons (4.6 billion - 1.2 billion = 3.4 billion gallons) generated by this group that would be expected to have been shipped off site during 1981. The first can generally be classified as measurement error in the survey data. Some of the quantities reported as generated by these generators may actually have been treated in exempt processes (for which Part A permit applications need not have been submitted) or shipped to POTW's, and would not have been included in the survey's estimates for quantities generated could they have been identified as such (see introduction to Part III). Inclusion of such quantities in the final survey data contributes to the uncertainty surrounding its estimates of total hazardous waste generation and management in the form of nonsampling error (see Sections 3.4 and 6.1).

Data supplied through the survey, however, suggests that some of these generators may actually be treating, storing, or disposing of hazardous wastes on site, even though they have not submitted Part A applications covering such activities as required under RCRA. The apparent on-site management practices of these generators would account for most of the remaining differences between the 5.4 billion gallons generated and the 800 million gallons shipped off site by the generators without RCRA-authorized (i.e., for which Part A permit applications have been submitted) TSD facilities. Information concerning these on-site management practices has been forwarded to EPA's enforcement offices for further investigation.

Thus, while the estimates of hazardous waste generation by generators without TSD facilities and quantities received from off site by TSD facilities appear on the surface to correlate very well, that correlation is apparently misleading. Nonetheless, the correlations that should be found in the data collected independently from generators and facilities does appear to hold in the survey's findings. The estimated quantity of hazardous waste shipped off site by RCRA-regulated generators (2.8 billion gallons) is estimated to equal almost exactly the quantity estimated to have been received by TSD facilities from RCRA-regulated generators.

7.4 Quantities Managed by Industry Type

The survey data indicate that close to two-thirds (66%) of all hazardous waste management in 1981 was undertaken by the chemical industry, while only a little over 25 percent of the management facilities were associated with the chemical industry. The petroleum refining industry accounts for 19 percent of the hazardous waste managed with only four percent of the management facilities. Thus, the two largest industries (chemical and petroleum refining) have roughly 30 percent of the management facilities, but account for 85 percent of all hazardous waste managed. Clearly, management is heavily concentrated in these two industries with a few very large management facilities found within each. Metal-related industries as a group (SIC 33-37) accounted for about seven percent of the hazardous waste managed in 1981.

The only nonmanufacturing industry among the top nine in terms of quantities of hazardous waste managed was SIC 49, the electric, gas, and sanitary services. This sector accounts for approximately three percent of the management facilities and also three percent of the hazardous waste managed. This industry includes SIC Code 4953, refuse systems.[2]

Figure 29 presents the distribution of quantities of hazardous waste managed for major categories of industry (as determined by primary SIC code).

7.5 Quantities Managed by Type of Waste Group

As previously stated in Section 6.4, survey-derived data on hazardous waste quantities broken down by waste group, although in great demand, are inconclusive. This conclusion is based, in part, on the previously discussed (see Section 6.4) disagreement between the survey's two primary sources of waste-specific quantity data (the Generator Questionnaire and the TSD General Questionnaire). Some of the other reasons why the survey results describing waste group quantities are inconclusive are enumerated in Section 6.4, with respect to quantitites of waste types generated. Other reasons for why the survey's waste group quantity estimates are inconclusive are presented below in relation to quantities of waste types managed by TSD facilities. This section will present some very rough estimates of quantities managed by type of waste group and describe the limitations of these data.

The TSD General Questionnaire allows a more detailed breakdown of waste groups than does the Generator Questionnaire. Whereas waste quantities are grouped into broad categories in

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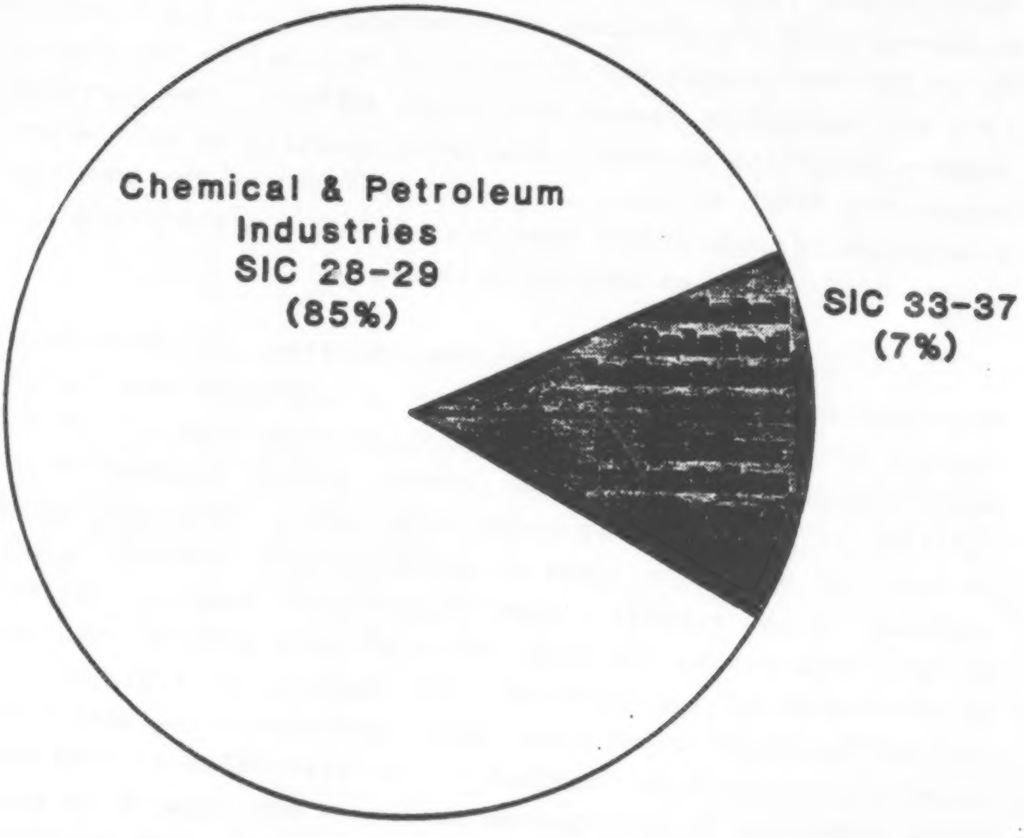
[2] Many commercial refuse systems may not have reported under SIC 49 because it was not their primary business, or because they failed to report an SIC code. "Commercial," as defined in this report, takes in much more than SIC 4953.

Figure 29

QUANTITIES OF HAZARDOUS WASTE MANAGED IN 1981 BY INDUSTRY TYPE



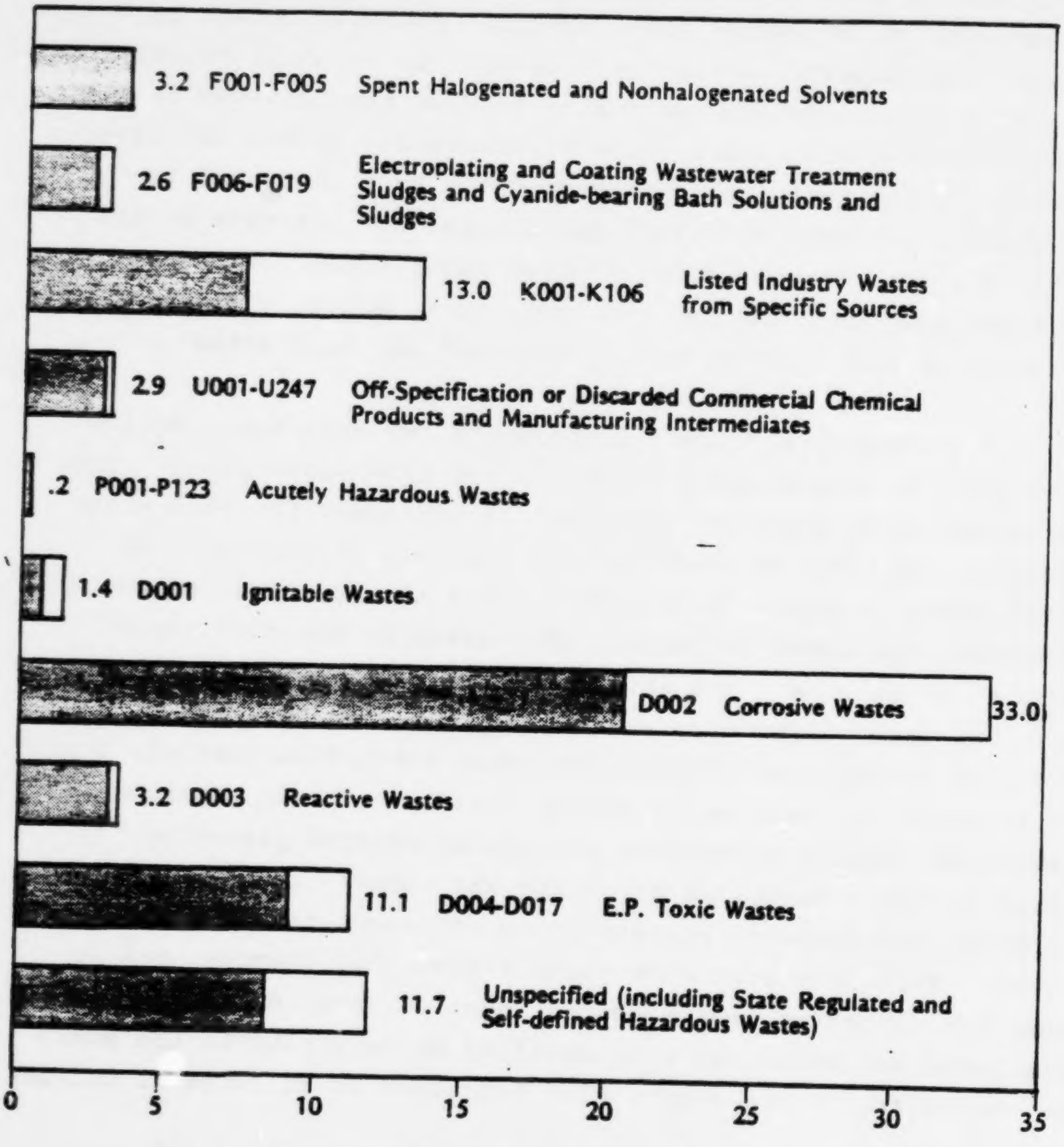
the Generator Questionnaire (e.g., "F" and "K" wastes are lumped together), quantities managed for individual waste codes can be retrieved from the TSD General Questionnaire. One of the major questions included in the TSD Questionnaire asked respondents to describe the flow of specific waste streams (designated by EPA waste codes) through the various treatment, storage, and disposal processes used in hazardous waste management at their facility. Up to the ten largest wastes could be reported in the question (a limit imposed to reduce respondent burden). The question asked respondents to report the total quantity of each waste stream "handled" at their facility, followed by the specific quantities of each stream that were treated, stored, and/or disposed of in the management cycle.

One of the major problems, however, in the design of the above mentioned question is that it used the term "handled," instead of "managed," in asking for the total quantity of each waste stream that was treated, stored, and/or disposed of at the facility in processes regulated under RCRA. (See the introduction to Part III for definitions of waste streams intended to be included in the survey). Some respondents, however, are believed to have interpreted the term "handled" more broadly than intended in the design of the question. For example, in addition to the desired "managed" quantities, some respondents included in their reports of quantities "handled:" (a) quantities of hazardous waste generated or transported that were not managed on site; (b) quantities included in stocks carried over from generation in previous years; or (c) quantities handled exclusively in RCRA-exempt processes, particularly in the case of aqueous corrosive waste streams that may have been treated exclusively in RCRA-exempt wastewater treatment tanks (see introduction to Part III). The questionnaire editing process attempted to identify and remove quantities that were reported under this broader interpretation (i.e., quantities confirmed to have been handled exclusively in exempt wastewater treatment tanks were subtracted from respondents reported quantities). However, due to imprecise question wording and the complicated nature of the editing process, some such undesired quantities are believed to remain in the final survey data. While the amount of such undesired quantities is believed to be small, their specific quantity cannot be determined. Furthermore, while their amount may be small relative to the 71.3 billion gallons estimated to have been managed in 1981, such undesired quantities could significantly affect estimated quantities for individual waste groups. As a result of the occurrence of these undesired quantities, the estimate of the total quantity "handled" for a given waste stream is believed to somewhat overstate the desired (but, as a result, unknown) estimate of the total quantity "managed" for that stream.

Therefore, Figure 30 presents two estimates, derived from the TSD General Questionnaire, for each waste group. The estimated total quantity "handled" is expressed for each waste group at the right of each bar, in billions of gallons. As noted above, however, this number tends to overstate the amount managed. The lower estimates, identified by the dark shaded portion of each bar, are intended to estimate the minimum quantity managed for each waste group, and are the result of choosing the largest of the individual quantities treated, stored, or disposed for each waste stream reported. These minimum estimates clearly understate the amount managed (ignoring sampling and nonsampling error for the moment) since treatment, storage, and disposal operations do not completely overlap each other. Part of a corrosive waste stream, for example, may be deep well injected, while another part is chemically treated. The lower estimates can be quantified by referring to the scale at the bottom of the graph, also expressed in billions of gallons.

Figure 30

QUANTITIES OF HAZARDOUS WASTE HANDLED BY MANAGEMENT FACILITIES IN 1981 BY TYPE OF WASTE GROUP (billions of gallons)



▨ Dark shaded portion represents the estimated minimum quantity managed (derived from the larger of quantities treated, stored, or disposed for each waste code, summed over all facilities).

Total bar indicates the quantity handled.

Note: Important notes are listed on the following page.

Notes to Figure 30

1.) A high degree of uncertainty is associated with the quantities shown due to questionnaire design, sampling and nonsampling error, and the lack of correlation with similar data derived from the Generator Questionnaire (see Figure 22).

2.) The sum of the amounts handled by the different waste groups exceeds the 71.3 billion gallons managed in the U.S. for two reasons. First, some respondents may have interpreted the term "handled" more broadly than intended in the survey design by including: additional quantities generated or transported that were not (i.e., treated, stored for more than 90 days, or disposed of) managed on-site; quantities in storage generated in previous years that were carried over as stocks in hand; and quantities managed in RCRA-exempt processes (see Introduction into Part III). Second, some hazardous waste quantities were reported by respondents under multiple hazardous waste codes, resulting in some such quantities being counted in more than one of the categories presented in the figure. Quantities reported under multiple hazardous waste codes generally fell into two groups:

    a.) An estimated 6.6 billion gallons of hazardous waste were represented by respondents as mixtures of two or more hazardous wastes that could not be disaggregated. Where such mixtures included wastes from more than one category (e.g., U122 and F001), the entire amount was included in each appropriate waste group presented in the figure (e.g., F001-F005 and U001-U247). Some mixtures included numerous waste codes and, thus, could be counted many times; and

    b.) Multiple classification also occurred wherever respondents reported a single waste (i.e., not a waste mixture) using more than one hazardous waste code. Many solvents, for example, are also ignitable and were sometimes reported as D001 as well as one of the F001-F005 solvent waste codes, again resulting in double counting.

In the case of the uppermost bar, representing quantities of spent halogenated and nonhalogenated solvents, classified under EPA waste codes F001 through F005, both estimates are the same. For acutely hazardous wastes, the quantities were too small to be graphically depicted as two estimates, but on a larger scale, the lower estimate would be about three-quarters of the amount handled, which is depicted in the full bar. For corrosive wastes (D002), however, the two estimates are considerably different.

The actual amount managed (as opposed to "handled") falls someplace in between the two estimates illustrated in Figure 30 (again, ignoring sampling and nonsampling error). Both estimates, however, may understate the quantity estimates for the "U" and "P" waste groups that are characteristically managed in small quantities and may not have been adequately represented by some of the 12 percent of all TSD facilities that have 10 or more waste streams.

Another problem in the analysis of waste group data is that there is a tradeoff between data quality and detail. The more detailed the breakdown, the more extreme the sampling error attached to the estimate is likely to be. Confidence intervals for individual waste groups were not calculated, but are expected to be very wide, indicating low statistical reliability. For this reason, the waste groups depicted in Figure 30 reflect convenient conceptual groupings and do not imply any acceptable degree of statistical reliability.

Taking sampling error, nonsampling error, and the limitations of the questionnaire into account, however, we cannot be confident that these quantity estimates reflect the actual waste group quantity distribution in 1981, except in very general terms. We can conclude, for example, that the quantity of corrosive wastes is probably greater than any other waste group, acutely hazardous waste quantities less than any other waste group, and that there are probably more "K" wastes (listed industry wastes from specific sources) and E.P. toxic wastes than ignitable (D001), or "U" wastes. Attempts to draw more detailed or specific conclusions from those waste-specific quantity data are, however, strongly discouraged.

7.6 Quantities Managed by Commercial Management Facilities

The number of facilities that can be characterized as commercial has been discussed previously (see Section 5.3). Table 15 reviews the distribution of commercial and other management type sites and shows the corresponding quantity measures.

Although commercial facilities make up nearly seven percent of all management sites, the data indicate they account for only about two percent of the actual hazardous waste managed. On the other hand, those facilities characterized as receiving 50 percent or less of the hazardous waste they managed from other firms make up 85.5 percent of the total number of all facilities. The data indicate that these facilities account for 91.4 percent of the managed hazardous waste. The category NSK (not specified by kind) came into being because of missing data resulting from the construction of the different management classes established here.

Table 15. Quantity Distribution for Commercial and Other Types of TSD Facilities

Type of Facility	Estimated Number of Facilities	Percent of Estimated Total Number	Estimated Quantity (million gallons)	Estimated Quantity (thousand metric tonnes)	Percent of Estimated Total Quantity
Commercial (privately owned and operated -- more than half of waste from other firms)	326	6.8%	1,300	4,800	1.9%
Publicly owned or operated and:					
More than half of waste from other sites	37	0.8%	24	89	0.1%
Half or less of waste from other sites	4,122	85.5%	65,000	240,000	91.4%
Other: NEC	9	0.2%	2	7	0.1%
NSK	324	6.7%	4,700	17,000	6.7%

7.7 Quantities of Hazardous Waste Treated, Stored and Disposed During 1981

Most of the 71.3 billion gallons[3] of hazardous waste managed at TSD facilities during 1981, was treated; approximately two thirds (66.5% or 47.5 billion gallons; see Figure 31)[3] of the hazardous waste managed by TSD facilities was treated. During 1981 there was a total of 1,495 TSD facilites that treated hazardous waste. The average quantity treated at each facility was 31.7 million gallons (see Table 16). Figure 31 presents the quantity of hazardous waste treated in 1981, in comparison to the quantities of hazardous waste stored and disposed. As the figure indicates, about thirty percent more waste was treated, than was stored; and more than three times as much waste was treated as was disposed. It should be pointed out, however, that significant portions of the quantity of treated hazardous wastes were also stored and/or later disposed. A strict comparison of these numbers is therefore discouraged. Section 7.3.1 contains a detailed discussion of the quantities of hazardous waste treated by each treatment technology.

About half of the hazardous waste that was managed by TSD facilities during 1981 was stored. Of the 71.3 billion gallons of managed waste, 36.5 billion gallons (or 51.1%) was stored at TSD facilities. During 1981, there were 4,299 TSD facilities that stored hazardous waste, and the average quantity stored per facility was 8.5 million gallons (see Table 16.) Figure 31 presents the quantity of hazardous waste stored in 1981, compared to the quantities treated and disposed. About 30

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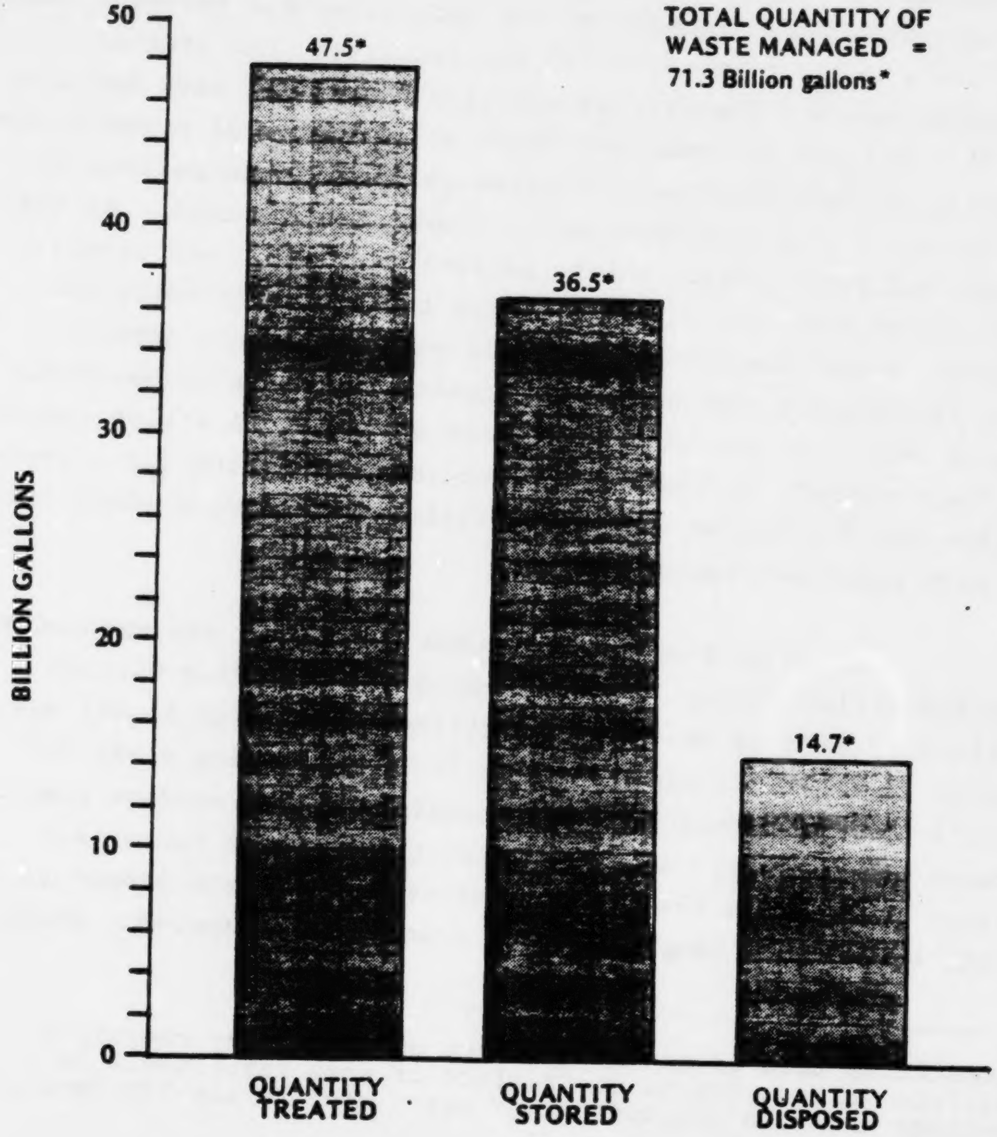
[3] Quantities treated and managed are overstated by roughly 5 billion gallons due to the failure of some respondents to exclude exempted treatment tank wastewater in the TSD General Survey.

Figure 31

QUANTITIES OF HAZARDOUS WASTE TREATED, STORED AND DISPOSED IN 1981



* Treated + Stored + Disposed exceeds 71.3 billion gallons managed due to multiple processing of some wastes. Roughly 5 billion gallons of RCRA-exempt wastewater are included in the treatment and management total.

Table 16. Total Quantities Managed, Average Quantities Managed per Facility, and Number of Facilities Treating, Storing and Disposing of Hazardous Waste in 1981

Process	Total Quantity Managed, By Process (Billions of Gallons)	Average Quantity Managed Per Facility, By Process (Millions of Gallons)	Number of Facilities Engaged In Each Process
Treatment	47.5*	31.7	1,495
Storage	36.5	8.5	4,299
Disposal	14.7	34.3	430

*Roughly 5 billion gallons of exempted wastewater are included due to the failure of some respondents to exclude these amounts from the TSD General Survey.

percent more waste was treated than stored, and about 60 percent less waste was disposed than stored. Section 7.3.2 contains a detailed discussion of the quantities of hazardous waste stored in each storage technology.

One fifth of the 71.3 billion gallons of hazardous waste that was managed during 1981 was disposed by TSD facilities during 1981. Approximately 14.7 billion gallons (or 20.6% of the managed hazardous waste) was disposed by 430 TSD facilities. The average quantity disposed per facility was 34.3 million gallons (see Table 16). Figure 31 presents the quantity of hazardous waste disposed in 1981, compared to the quantities treated and stored. More than twice as much waste was stored, and more than three times as much waste was treated, than was disposed. Most of the quantities stored, however, were subsequently treated and disposed of, rendering strict comparisons of the quantities treated, stored, and disposed of less meaningful.

The sum of the quantities of waste that were treated, stored and disposed is greater than the total quantity that was managed, due to multiple processing of some wastes. An important note, however, is that the sum of hazardous wastes treated and disposed (62.2 billion gallons) significantly exceeds the estimated total quantity of hazardous waste generated during 1981. Thus, even when double counting of quantities treated and disposed of is accounted for by assuming that all wastes disposed of were first treated, the survey findings fail to indicate a short fall between the quantity of hazardous waste generated and the quantities subsequently finding their way into final treatment and disposal processes regulated under RCRA in 1981.

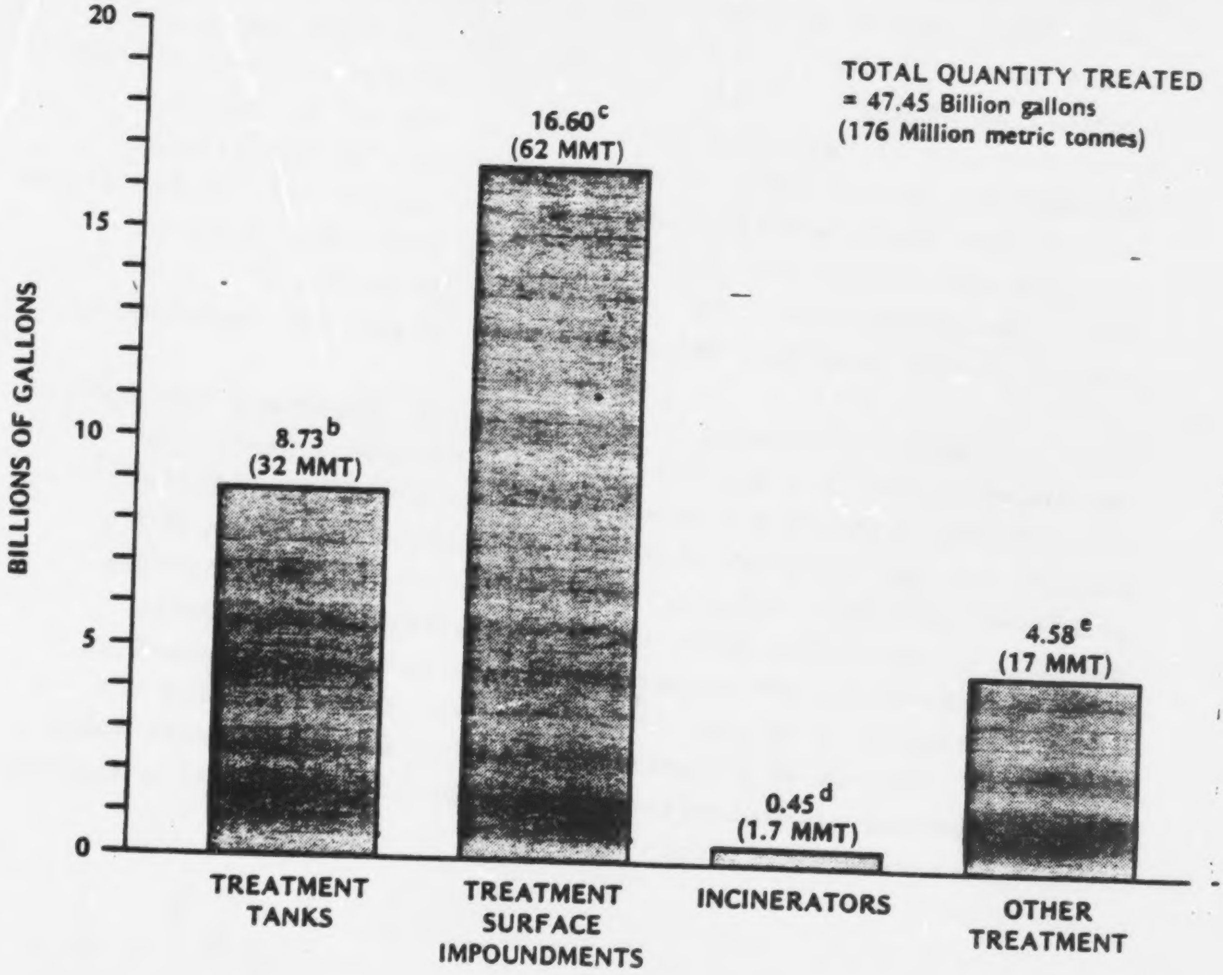
7.7.1 Quantities of Hazardous Waste Treated in 1981, by Treatment Process Type

Treatment surface impoundments handled the greatest single portion of hazardous waste treatment, treating an estimated 16.6 billion gallons (62 million metric tonnes) during 1981. As shown in Figure 32, there was almost twice as much hazardous waste treatment in surface impoundments as there was in tanks. There was nearly forty times more treatment in surface impoundments than there was in incinerators. There were about 410 treatment surface impoundment facilities treating hazardous waste during 1981. They treated an average of 40.6 million gallons (151,000 metric tonnes) of hazardous waste per facility (see Table 17). However, as is shown in Table 18, a very large percentage of the total quantity of hazardous waste that is treated in surface impoundments is treated by a very small number of facilities. Half of that waste was treated by only six percent of the facilities treating their hazardous waste in surface impoundments during 1981. Forty-two percent of those facilities accounted for 99 percent of the hazardous waste treatment in surface impoundments.

As was indicated in Section 5.4.1, treatment surface impoundments that are employed to treat hazardous wastewater under NPDES (National Pollutant Discharge Elimination System) permits are _not_ excluded from RCRA regulation (although NPDES permitted treatment tanks _are_ excluded). Thus, the estimated quantity of hazardous waste treated in surface impoundments _includes_ hazardous wastewater treated by facilities engaged in NPDES wastewater treatment in surface impoundments, while the estimated quantity of hazardous waste treated in treatment tanks _excludes_ hazardous wastewaters treated by those facilities engaged in NPDES wastewater treatment in tanks.

Figure 32

QUANTITIES OF HAZARDOUS WASTE TREATED IN 1981, BY TREATMENT PROCESS TYPE
(billions of gallons)



Note: Footnotes are listed on the following page.

Notes to Figure 32

[a] The total quantity treated includes roughly five billion gallons (20 million metric tonnes) of RCRA-exempt wastewater misreported in the TSD General Survey. Due to this and the large sampling errors associated with quantity estimates of the Tank, Surface Impoundment and TSD General Surveys, the total quantity treated is greater than the sum of the processes even though the processes should be greater to the extent they overlap.

[b] Estimated by multiplying the number of facilities with treatment tanks by the mean of Tank Questionnaire question 18, quantity of hazardous waste treated in tanks.

[c] Estimated by multiplying the number of facilities with treatment surface impoundments by the mean of Surface Impoundment Questionnaire question 5, quantity of hazardous waste treated in surface impoundments.

[d] Estimated by multiplying the number of facilities with active incinerators in 1981 by the mean of TSD General Questionnaire question 17, quantity of hazardous waste treated, for incinerated wastes only. This may be understated since only the 10 wastes handled in the greatest quantity were reported.

[e] Estimated by multiplying the number of facilities with other treatment in 1981 by the mean of the TSD General Questionnaire question 17, quantity of hazardous waste treated, for wastes treated by other treatments only. Combinations with tank, surface impoundments or incinerators were not included, and so waste streams may also have been excluded where there were more than 10 waste streams in a facility.

Table 17. Total Quantities Treated, Average Quantities Treated and Number of Facilities Treating Hazardous Waste by Each Treatment Process Type

Treatment Process Type	Total Quantity Treated By Process Type (Billion Gallons)	Total Quantity Treated By Process Type (Million Metric Tonnes)	Average Quantity Treated By Process Type (Million Gallons)	Average Quantity Treated By Process Type (Thousand Metric Tonnes)	Number of Facilities Treating By Each Process Type
Treatment Tanks	8.73	32	14.3	53	609
Treatment Surface Impoundments	16.60	62	40.6	151	410
Incinerators	0.45	1.7	1.9	7	240
Other Treatment	4.58[a]	17[a]	12.9[a]	48[a]	392[b]

[a] Based on 355 facilities that were not in combination with the above processes.

[b] Includes 37 facilities that were in combination with the above processes.

.Table 18. Size Distributions in the Treatment Technologies: Proportions of the Population Accounting for 33 Percent, 50 Percent and 99 Percent of the Quantities of Waste Treated in Each Technology

Treatment Technology	Percent of the Population That Accounts For 33% of the Waste Treated in Each Technology	Percent of the Population That Accounts For 50% of the Waste Treated in Each Technology	Percent of the Population That Accounts For 99% of the Waste Treated in Each Technology
Treatment Tanks	1%	2%	30%
Treatment Surface Impoundments	3%	6%	42%
Incinerators	1%	4%	47%

Treatment tanks accounted for the next greatest quantity of hazardous waste treatment, with an estimated 8.7 billion gallons (32 million metric tonnes) of treatment during 1981. As Figure 32 indicates, there was almost twice as much hazardous waste treatment in surface impoundments, compared to tanks. But roughly twenty times more waste was treated in tanks than was incinerated, and almost twice as much treatment occurred in tanks, compared to "other treatment" methods. There were about 609 treatment tank facilities in 1981, and they treated an average of 14.3 million gallons (53,000 metric tonnes) of hazardous waste per facility. The average treatment quantity for treatment tanks is about one third of the average treatment quantity for treatment surface impoundments. However, as Table 18 indicates, the bulk of the total quantity of hazardous waste treated in tanks was treated by a very small proportion of the facilities. About two percent of the facilities that treated hazardous waste in tanks in 1981 treated 50 percent of the waste that was treated in tanks. Just 30 percent of the facilities accounted for 99 percent of hazardous waste treatment in tanks.

Many TSD facilities indicated that they treated hazardous wastewaters in tanks that were covered under NPDES permits. As is indicated in Section 1.3, such tanks are excluded from regulation under RCRA, and this survey was not designed to provide estimates of the quantities of hazardous wastewater treated in tanks operating under NPDES permits in 1981. However, a large number of survey respondents reported that they operated treatment tanks under NPDES permits in 1981. This suggests that, had hazardous wastewater treatment quantities been included in the quantity estimate for treatment tanks, the estimate would have been much larger.

Incinerators treated the least amount of hazardous waste of the listed treatment processes. About 450 million gallons (1.7 million metric tonnes) of waste was incinerated during 1981. As is shown in Figure 32, about twenty times more waste was treated in tanks, and about forty times more waste was treated in surface impoundments. Nearly twice as much hazardous waste (807 million gallons or 3.0 million metric tonnes) was disposed in landfills (see Section 7.3.3). Even the category used to specify other unlisted types of waste treatment is eight times the quantity that was incinerated. Table 17 indicates that an average of 1.9 million gallons (17,000 metric tonnes) was incinerated per incinerator facility during 1981. However, as Table 18 indicates, less than 4 percent of the population of incinerator facilities accounts for half of the total quantity of hazardous waste incinerated, and the top 47 percent of incinerator facilities account for 99 percent of all hazardous waste incineration.

Treatment methods other than the three treatment methods specified in the survey questionnaire were used to treat approximately 4.6 billion gallons of hazardous waste during 1981. There were an estimated 392 facilities using these treatment methods, to treat an average of 12.9 million gallons of hazardous waste per facility. Other treatment methods included open burning, explosion, treatment in waste piles, and treatment in containers. In addition, some treatment technologies that were classified by survey respondents as "other," but unspecified, may prove to be classifiable as a type of treatment in tanks or impoundments.

The estimated total quantity treated (see Section 7.3) from the TSD General Survey is 47.5 billion gallons (176 million metric tonnes). The sum of treatment quantities estimated from the technology component surveys (29.4 billion gallons or 109 million metric tonnes) is considerably less than the total quantity treated according to the TSD General Survey. The difference is even greater considering that there is at least some overlap of the various treatment technologies.

Two factors play a large part in explaining the more than 18 billion gallon (67 million metric tonne) difference. First, roughly 5 billion gallons (20 million metric tonnes) is exempt from RCRA regulation, and should be excluded from the TSD General Survey's estimate of total treatment as it is from the Tank Survey. Second, and most important, sampling error is large for both the TSD General Survey treatment estimate and the technology surveys' aggregate treatment estimate.

The 95 percent confidence interval associated with the 45.5 billion gallon TSD General Survey treatment estimate is ± 18 billion gallons. This overlaps with the ± 10 billion gallon confidence interval surrounding the 29.4 billion gallon technology surveys' estimate. Stated in millions of metric tonnes (MMT) this would be 176 MMT ± 67 MMT for the TSD General Survey, and 109 MMT ± 37 MMT for the aggregated technology surveys' estimate. These overlapping confidence intervals do not necessarily indicate that there is no statistically significant difference between the two estimates.[4]

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[4] Since the samples are not independent, their covariance would have to be determined (after making adjustments for excludable wastewater and overlap of treatment technologies) in order to test the statistical significance of the difference.

7.7.2 Quantities of Hazardous Waste Stored in 1981, by Storage Process Type

Most of the hazardous waste stored in 1981 was stored in surface impoundments. Surface impoundments were used to store an estimated 14.1 billion gallons (52 million metric tonnes) of hazardous waste at 552 facilities. (See Figure 33 and Table 19.) This represents an average of 25.6 million gallons (95,000 metric tonnes) per facility.[5] Almost three times more waste was stored in surface impoundments than was stored in tanks. Storage containers, waste piles and other storage methods accounted for 50 to 100 times less hazardous waste storage.

As was indicated in Section 1.3, and again in Section 5.4.2, on-site accumulation of hazardous waste in tanks or containers for less than 90 days is excluded from most RCRA regulations pertaining to hazardous waste storage. However, this "90-day rule" does not apply to hazardous waste that is accumulated or stored in surface impoundments. Thus the estimated quantity stored in surface impoundments in 1981 includes quantities that were "accumulated" on site for less than 90 days, while the estimated quantities stored in containers and tanks do not include accumulated quantities.

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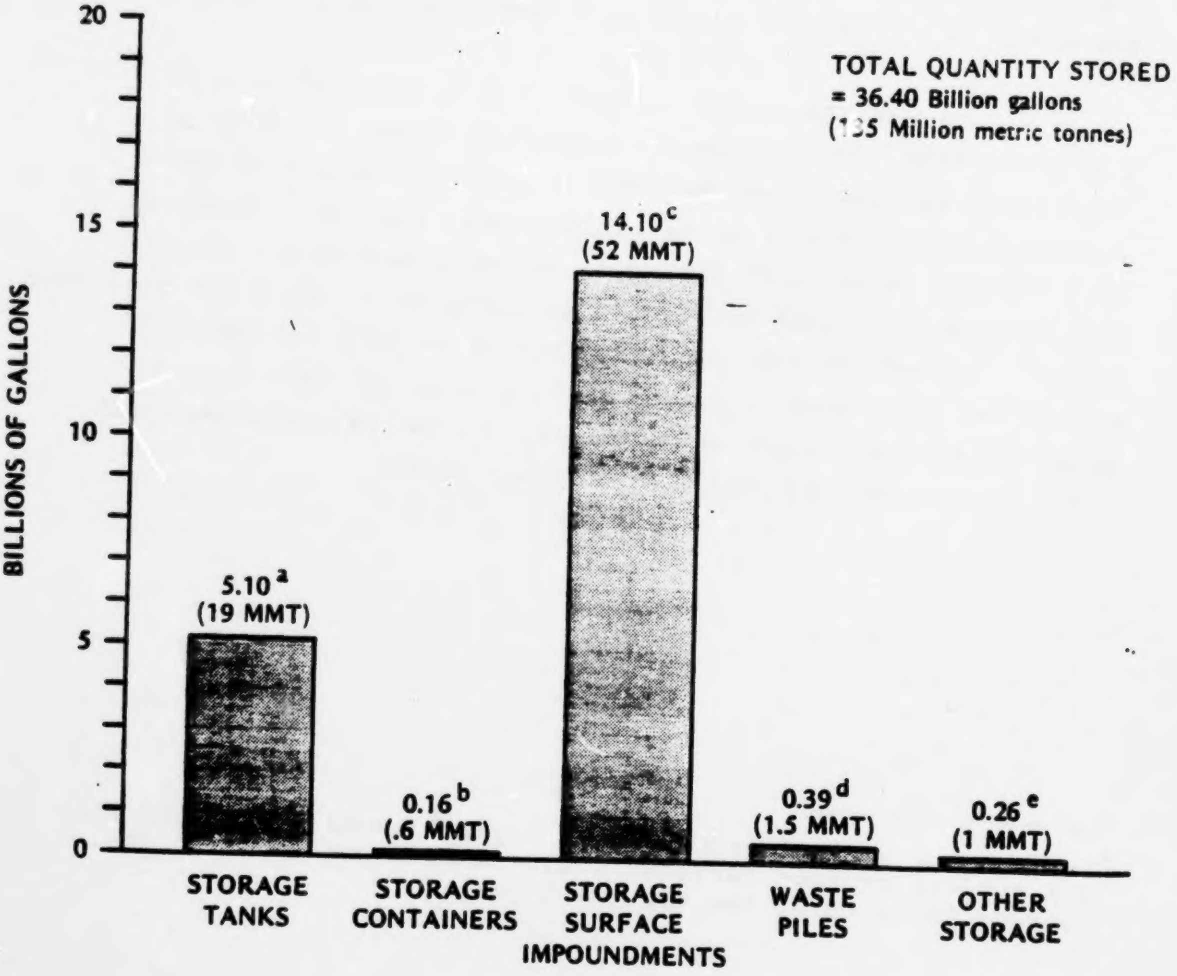
[5] Because the size distribution is highly skewed (see Table 21), the typical storage facility would be much smaller than the average for each of the process types.

Figure 33

QUANTITIES OF HAZARDOUS WASTE STORED IN 1981, BY STORAGE PROCESS TYPE
(billions of gallons)



Note: Footnotes are listed on the following page.

Notes to Figure 33

[a] Estimated by multiplying the number of facilities with storage tanks by the mean of Tank Questionnaire questions 8 and 9, quantity carried over in storage tanks from 1980, plus the quantity entered into storage in tanks in 1981.

[b] Estimated by multiplying the number of facilities with storage in containers by the mean of Container Questionnaire questions 8 and 9, quantity carried over in storage containers from 1980, plus the quantity entered into storage in containers in 1981.

[c] Estimated by multiplying the number of facilities with storage surface impoundments by the mean of Surface Impoundment Questionnaire question 5a, quantity of hazardous waste stored in surface impoundments. This represents an underestimate of the quantity of hazardous waste stored in surface impoundments, since surface impoundment facilities almost never include "carryover" from previous years in their estimates of quantities stored.

[d] Estimated by multiplying the number of facilities with regulated waste piles by the mean of the TSD General Questionnaire question 17, quantity of hazardous waste entering storage in 1981, for waste piled wastes only. This represents an underestimate of the total quantity of hazardous waste stored in surface impoundments, because question 17 includes only waste that entered storage in 1981, and because question 17 obtained data only for the ten wastes handled in greatest quantity.

[e] Estimated by multiplying the number of facilities with other storage by the mean of Treatment, Storage and Disposal Questionnaire question 17c, quantity of hazardous waste entering storage in 1981, for waste stored by other methods only. This represents an underestimate of the total quantity of hazardous waste stored by other methods, because question 17c includes only waste that entered storage in 1981, and because question 17c obtained data only for the ten wastes handled in greatest quantity.

Table 19. Total Quantities Stored, Average Quantities Stored and Number of Facilities Storing Hazardous Waste by Storage Process Type

Treatment Process Type	Total Quantity Stored, By Process Type (Billion Gallon		Average Quantity Stored, By Process Type (Million Gallons		Number of Facilities Stored By Each Process Type
		(Million Metric Tonnes)		(Thousand Metric Tonnes)	
Storage Tanks	5.10	19	3.57 (Carry over = 0.2, Entered = 3.6	13 (Carry over = .7 Entered = 13.4)	1,428
Storage Containers	0.16	.6	.045 (Carry over = .009, Entered = .039	17 (Carry over = .03 Entered = .15)	3,577
Storage Surface Impoundments	14.10	52	25.6	95	552
Waste Piles	0.39	1.5	2.2	8	174
Other Storage	.26a	.97a	1.9a	4a	139[b]

Furthermore, unlike storage tanks, storage surface impoundments that are employed to store hazardous wastewater under NPDES permits are not excluded from regulation under RCRA. Thus, the estimated quantity of waste stored in surface impoundments includes hazardous wastewaters that are stored in surface impoundments operated under NPDES permits, while the estimated quantity of hazardous waste stored in tanks excludes hazardous wastewaters that are stored in tanks operated under NPDES permits.

Tanks were used to store the second largest quantity of hazardous waste. About 5.1 billion gallons (19 million metric tonnes) were stored by 1,428 facilities. Approximately 180 million gallons (0.4%) of the 5.1 billion gallons were carried over in storage from 1980 (see Figure 33 and Table 19.) As was indicated above, the estimated quantity of hazardous waste stored in tanks does not include hazardous wastewaters stored in tanks operated under NPDES permits, nor does it include quantities of hazardous waste accumulated on site under the 90-day rule.[6]

Storage tank quantities were dominated by two facilities in the sample that represented almost three-quarters of all RCRA-regulated hazardous waste entering storage tanks in 1981. The largest facility sampled represented 52 percent of the total quantity entering storage, but only 0.3 percent of the storage tank facility population. Ninety-nine percent of storage tank quantities were accounted for by only 27 percent of the storage tank population (see Table 20).

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[6] As was noted in Section 5.4.2, approximately 15 percent of the regulated hazardous waste generators used tanks for accumulation of hazardous waste under the 90-day rule during 1981.

Storage containers were used by 3,577 facilities to store about 160 million gallons (600,000 metric tonnes) of hazardous waste. Seventeen precent of this, or 27 million gallons (100,000 metric tonnes) was carried over in storage. As was indicated above, the quantity of hazardous waste stored in containers does not include quantities of hazardous waste accumulated on site under the 90-day rule. About 51 percent of the 14,098 hazardous waste generators used containers for on-site accumulation of hazardous waste under the 90-day rule in 1981. While storage in containers was the most frequently used technology among all hazardous waste management technologies, it ranked smallest among the four storage technologies surveyed in terms of quantity managed.

Quantities of hazardous waste entering storage in containers were also concentrated in a relatively small number of facilities, although the distribution was not as highly skewed as in storage tanks. Table 20 indicates that a third of the containers' waste was stored by one percent of the facilities entering hazardous waste into storage containers during 1981. Two percent of the population accounted for half the waste and two thirds percent of the population accounted for 99 percent of the waste entering container storage.

Waste piles were used by 174 facilities to store an estimated 390 million gallons (1.5 million metric tonnes)[7] of waste. Storage tanks were used to store more than ten times that quantity of waste, and surface impoundments stored more than thirty times that quantity. As was true with surface

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[7] The estimates of the quantity stored in waste piles was developed by multiplying the number of facilities with in-use waste piles from the Waste Pile Questionnaire, by the mean quality of hazardous waste entered into storage in waste piles, from Question 17 of the TSD General Questionnaire, which is limited to the ten wastes handled in greatest quantity.

Table 20. Size Distributions in the Storage Technologies: Proportions of the Population Accounting for 33 Percent, 50 Percent and 99 Percent of the Quantities of Waste Stored in Each Technology

Storage Waste	Percent of the Population That Accounts For 33 Percent of the Waste Stored in This Technology	Percent of the Population That Accounts For 50 Percent of the Waste Stored in This Technology	Percent of the Population That Accounts For 99 Percent of the Waste Stored in This Technology
Storage Tanks[a]	b	b	27%
Containers[a]	1%	2%	67%
Storage Surface Impoundments	1%	2%	27%

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[a] The distribution of quantities entering storage shown here should be similar to quantities stored since quantities carried over are relatively small (See Table 20).

[b] The largest facility sampled represented 0.3 percent of the population and 52 percent of the quantity entering storage in 1981.

impoundments, waste that is "accumulated" on site in waste piles for less than 90 days is not excluded from regulation as hazardous waste storage under RCRA. Thus the estimated quantity of hazardous waste stored in waste piles does include waste that was stored on site for less than 90 days. However, the estimated quantity managed by waste piles does not include waste that may have been treated or disposed in waste piles, since at the time of the survey, waste piles were regarded by the EPA as only a storage process.

There were 139 facilities that used storage methods other than impoundments, tanks, containers or piles in 1981. These facilities handled about 260 million gallons (approximately one million metric tonnes)[8] of hazardous waste.

7.7.3 Quantities of Hazardous Waste Disposed in 1981, by Disposal Process Type

While the largest number of disposal facilities have landfills, 199 facilities, the largest quantity of waste is disposed in underground injecton wells (see Figure 34 and Table 21). Approximately 8.6 billion gallons (32 million metric tonnes) of waste managed as hazardous waste was disposed in injection wells in 1981, which is more than ten times the quantity disposed in landfills. The average quantity disposed per facility for the 87 facilities that used injection wells for disposal was 99.0 million gallons (370,000 metric tonnes). As is shown in Table 22, 10 percent of the injecton wells facilities were

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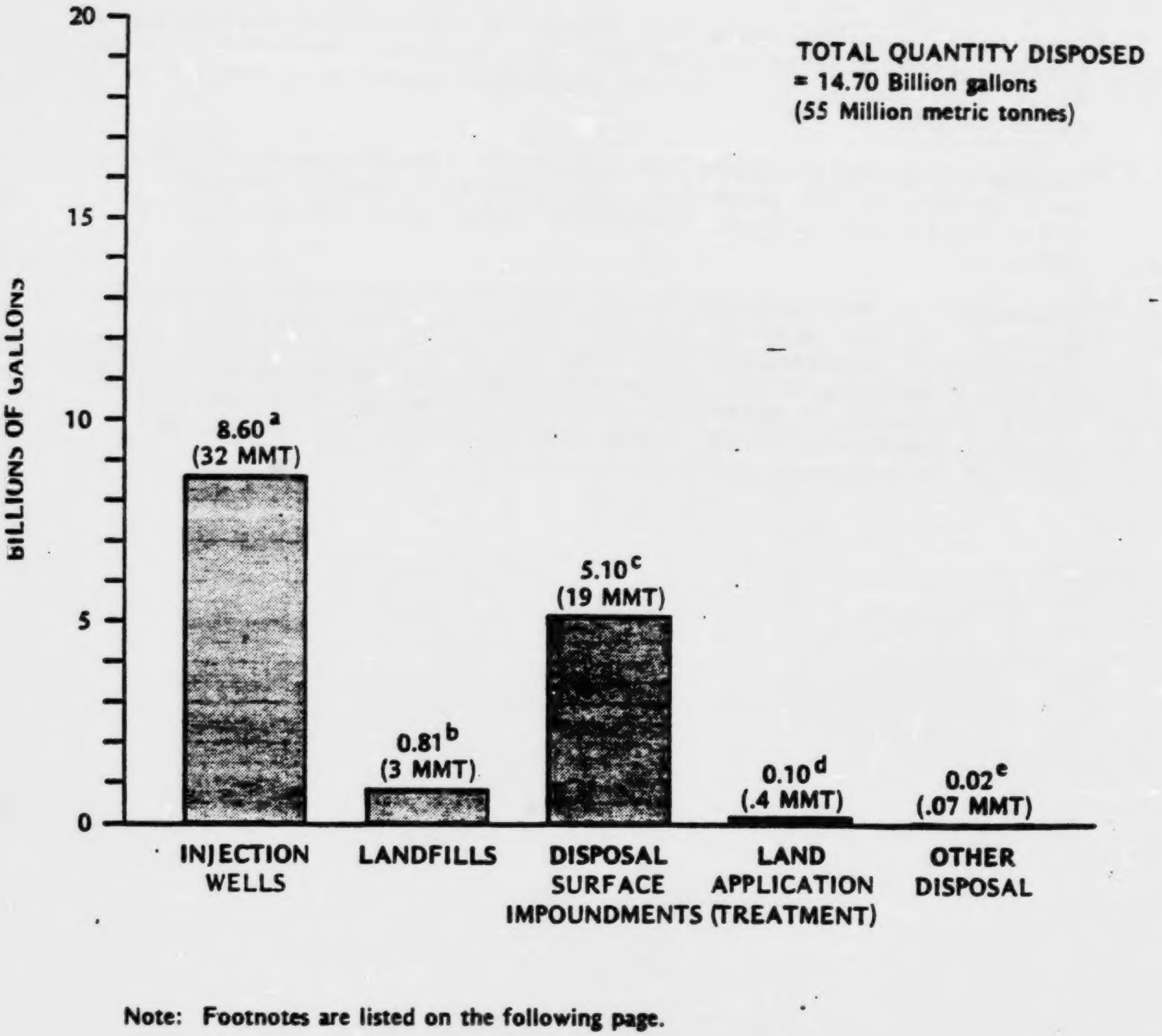
[8] The quantity estimated for other storage methods is an underestimate derived from question 17 of the TSD General Questionnaire, which is limited to the ten wastes handled in greatest quantity, and limited to waste that entered storage in 1981.

Figure 34

QUANTITIES OF HAZARDOUS WASTE DISPOSED IN 1981, BY DISPOSAL PROCESS TYPE

(billions of gallons)



Note: Footnotes are listed on the following page.

Notes to Figure 34

[a] Estimated by multiplying the number of facilities with injection well disposal by the mean for Injection Wells Questionnaire question 4, quantity of waste disposed by injection wells in 1981.

[b] Estimated by multiplying the number of facilities with landfills by the mean for Landfills Questionnaire question 5a2, quantity of hazardous waste disposed in landills in 1981.

[c] Estimated by multiplying the number of facilities with disposal surface impoundments by the mean for Surface Impoundment Questionnaire question 5, quantity of hazardous waste disposed in surface impoundments in 1981.

[d] Estimated by multiplying the number of facilities with land application by the mean for Land Treatment Questionnaire question 6, quantity of hazardous waste land treated during 1981.

[e] Estimated by multiplying the number of facilities with other disposal by the mean of the TSD Questionnaire question 17i, quantity of hazardous waste disposed in 1981, for waste disposed by other methods only. This represents an underestimate of the total quantity of hazardous waste disposed by other methods because question 17i obtained data only for the ten wastes handled in greatest quantity.

Table 21. Total Quantities Disposed, Average Quantities Disposed and Number of Facilities Disposing of Hazardous Waste by Each Disposal Process Type

Disposal Process Type	Total Quality Disposed By Process Type		Average Quantity Disposed By Process Type		Number of Facilities Disposing By Each Process Type
	(Billion Gallons)	(Million Metric Tonnes)	(Million Gallons)	(Thousand Metric Tonnes)	
Injection Wells	8.60	32	99.0	370	87
Landfills	0.81	3	4.1	15	199
Disposal Surface Impoundments	5.10	19	44.0	160	116
Land Application (Treatment)	0.10	.4	1.4	5	70
Other Disposal	0.02	.07	3.3	12	7

Table 22. Size Distributions in the Disposal Technologies: Proportions of the Population Accounting for 33 Percent, 50 Percent and 99 Percent of the Quantities Waste of Disposed in Each Technology

Disposal Technology	Percent of the Population That Accounts For 33 Percent of the Waste Disposed in Each Technology	Percent of the Population That Accounts For 50 Percent of the Waste Disposed in Each Technology	Percent of the Population That Accounts For 99 Percent of the Waste Disposed in Each Technology
Injection Wells	6%	10%	63%
Landfills	2%	3%	52%
Disposal Surface Impoundments	2%	3%	20%
Land Application	7%	13%	65%

responsible for fifty percent of the total quantity of disposal in injection wells. It is significant to note, however, that the injection well population was the least skewed of all the hazardous waste treatment, storage, and disposal process populations. A greater percentage of the injection well sites are "larger" than was observed in any of the other processes.

The second largest quantity of hazardous waste was disposed in disposal surface impoundments. Approximately 5.1 billion gallons of waste was disposed in 1981 (see Figure 34 and Table 21). The 116 facilities that disposed of waste in surface impoundments disposed an average of 44.0 million gallons (160,000 metric tonnes) of hazardous waste per facility. However, three percent of the facilities with disposal surface impoundments disposed of 50 percent of the waste disposed in surface impoundments, and 99 percent of the waste was disposed by just 20 percent of the facilities. In fact, most of the disposal in surface impoundments was observed at a single extremely large facility. Were it not for the inclusion of this facility in the sample, the estimated quantity of hazardous waste disposed in surface impoundments would be substantially reduced.

About 810 million gallons (3 million metric tonnes) of hazardous waste were disposed in landfills during 1981. As is shown in Figure 34 this represents about one-tenth of the waste that was disposed in injection wells and about one-sixth of the waste that was disposed in surface impoundments. Disposal in landfills, however, was about eight times greater than disposal by land application (treatment). The 199 facilities using landfills for hazardous waste disposal disposed an average of 4.1 million gallons (15,000 metric tonnes) of hazardous waste per facility during 1981. But, as is shown in Table 22, a small number of facilities were responsible for a large proportion of the waste disposed in landfills. Approximately three percent of the facilities disposed of 50 percent of the hazardous waste landfilled.

As is shown in Figure 34 and Table 21, about 100 million gallons (400,000 metric tonnes) of hazardous waste was disposed by land application (treatment) during 1981. The 70 facilities using land application for hazardous waste disposal disposed of an average of 1.4 million gallons (5,000 metric tons) of waste per facility during 1981. However, as is shown in Table 22, only 13 percent of the land application facilities accounted for 50 percent of the disposal by land application.

About 20 million gallons (70,000 metric tonnes) of hazardous waste were disposed by other methods during 1981. The estimated 7 facilities using other disposal methods disposed of an average of 3.3 million gallons (12,000 metric tonnes) of waste by other methods during 1981.

PART IV (Section 8)

CAPACITY

8. CAPACITY OF TREATMENT, STORAGE AND DISPOSAL FACILITIES

The preceding sections have provided an analysis of quantities of hazardous waste managed in 1981. This final quantitative section of the report focuses attention on the capacity of these facilities to treat, store and dispose of additional quantities of hazardous waste. Capacity availability is an important issue in planning for adequate management of future quantities of hazardous waste.

Respondents to the national TSD General Questionnaire were asked what quantities of hazardous waste (a) actually were and (b) could have been treated, stored or disposed of in 1981. The quantities reported in the "could have been" category were intended to represent the facility's annual capacity to treat, store, and dispose of these wastes. As a result, it is possible to calculate both the "percent utilization of capacity" and the "unused annual capacity" as of the beginning of 1982. This section also analyzes the extent to which hazardous waste management capacity is "readily available" in that it is available at facilities that receive over half of their waste from other firms (i.e., commercial facilities).

The concept of "capacity" requires some careful definition. The following points of clarification are provided to qualify the meaning of capacity as the term is used in the analysis that follows:

- The reported capacity was based only on those facilities estimated to have managed RCRA-regulated hazardous waste in 1981. Almost as many more facilities were "out of scope" (ineligible for the survey) because they did not manage hazardous wastes in 1981, even though they were listed in

EPA's HWDMS file of Part A permit applications;[1] to the extent that these out-of-scope facilities actually manage or intend to manage hazardous waste, additional capacity beyond that indicated by the findings presented in this section could be available.

- The data represent capacity on January 1, 1982. Additional capacity may have been "used up" in the past two years. Also, additional capacity may have been "created" at existing facilities.
- The reported capacity represents the respondents' own perceptions of additional quantities of hazardous waste that "could have been treated, stored or disposed of in 1981." Presumably, this included only existing capacity; no attempt was made to obtain potential for expanding capacity.
- There is some uncertainty as to the meaning of the respondents' answers to the capacity questions. While the answers clearly represent annual "flow" capacity for treatment processes and some disposal process (e.g., underground injection), it is unclear, in the case of landfills particularly, whether respondents reported annual input rates or total fixed capacity in response to the question: "What quantity of hazardous waste could have been disposed of in 1981?" This report assumes, however, that the data represent annual input capacity for all processes.

The above points underline the reasons for carefully interpreting the "capacity" data that follow. Like other quantity data in this report, important relationships between different types of management facilities can be observed, even though the capacity levels may be of questionable accuracy. Sections 8.1 to 8.4 will examine the relationships between different types of TSD capacity (commercial, on-site, and regional), and their capacity utilization rates. These data were imputed based on the estimated treatment, storage, and disposal quantities presented in Section 7.3, and their national capacity utilization rates.[2]

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[1] Among the facilities listed on EPA's HWDMS file of Part A, the survey estimated that 4,818 actually managed hazardous waste in 1981. The remaining 3,700 facilities listed on the Part A file are estimated to have not entered quantities of hazardous waste into treatment, storage or disposal in 1981, and thus were outside the scope of the survey.

8.1 U.S. Capacity Utilization: Commercial and On-Site Management Facilities

Ample hazardous waste management capacity appears to be available for 1981 levels of hazardous waste generation. Only 23 percent of treatment, 36 percent of disposal, and, at most, 64 percent[3] of storage capacity was utilized across the U.S.

The treatment, storage, and disposal capacity utilization rates are presented in the "c" rows of Table 23. This table illustrates the importance of on-site capacity compared to commercial capacity. "Commercial" facilities, defined here as those private or public facilities receiving more than half of their waste from off site, make up less than one percent of total treatment capacity, six percent of disposal capacity, and three percent of storage capacity. Thus, the U.S. hazardous waste management capacity and utilization levels are dominated by on-site capacity.

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[2] Treatment, storage and disposal capacity utilization rates were calculated by 100+ C/D, where C = weighted mean of quantities that "entered," and D = weighted mean of quantities that "could have been entered."

[3] This may significantly overstate storage capacity utilization since the largest facility, which represented 22 percent of the total storage capacity, did not provide capacity data and was therefore assumed to have fully utilized its storage capacity in 1981. If this facility were not included, or had it been assumed to have the same storage capacity utilization rate as the rest of the storage populations, the U.S. percentage of hazardous waste storage capacity utilization would be 48 percent.

Table 23. Summary of 1981 U.S. "Commercial" and On-Site Hazardous Waste Management Capacity Utilization

	Commercial[1] Capacity	On-Site Capacity	Total U.S. Capacity
TREATMENT			
a) Total Capacity in Bill. Gal. (MMT)	1.7 (6)	203.7 (758)	205.4 (764)
b) Unused Capacity in Bill. Gal. (MMT)	1.1 (4)	156.8 (583)	157.9 (587)
c) Cumulative Capacity Utilization[2]	35%	23%	23%
d) Average Facility Capacity Utilization[3]	37%	51%	50%
STORAGE			
a) Total Capacity in Bill. Gal. (MMT)	1.8 (7)	55.2 (205)	57.0 (212)
b) Unused Capacity in Bill. Gal. (MMT)	1.1 (4)	19.4[4] (72)	20.5[4] (76)
c) Cumulative Capacity Utilization[2]	39%	65%[4]	64%[4]
d) Average Facility Capacity Utilization	47%	57%	57%
DISPOSAL			
a) Total Capacity in Bill. Gal. (MMT)	2.4 (9)	38.7 (144)	41.1 (153)
b) Unused Capacity in Bill. Gal. (MMT)	1.6 (6)	24.7 (92)	26.3 (98)
c) Cumulative Capacity Utilization[2]	33%	36%	36%
d) Average Facility Capacity Utilization[3]	42%	56%	53%

MMT = Million metric tonnes.

Note: Footnotes are listed on following page.

Notes to Table 23

[1] "Commercial" facilities are defined in various ways in this and other reports. Here commercial facilities are defined as those receiving more than 50 percent of their waste from off site. This includes public as well as private facilities.

[2] Cumulative capacity utilization is the total quantity treated, stored or disposed of in the U.S., divided by the total T, S, or D capacity.

[3] Average facility capacity utilization is a simple average of the utilization rates computed for the individual facilities.

[4] These data reflect the assumption that the largest storage facility (representing 12.4 billion gallons) had no unused capacity. This is an extreme assumption that almost certainly understates unused capacity and overstates cumulative capacity utilization.

The U.S. capacity and utilization levels are also strongly influenced by the very large management facilities. Unused capacity and low utilization rates tend to be concentrated in the largest facilities. A comparison of the average facility capacity utilization rate (the "d" rows of Table 23) and the cumulative capacity utilization rate (the "c" rows) indicates that the average facility rate is significantly higher for treatment and disposal.[4] Low capacity utilization rates at large facilities caused the cumulative rate to fall significantly below the average facility rate. The highly skewed distributions of unused capacity shown in Table 24 accentuate this effect. Large commercial facilities also seemed to have lower capacity utilization rates than the average commercial facility, but the difference was not as pronounced as for the on-site facilities, owing to the greater homogeneity of the commercial population.

In examining the relative scale of commercial versus on-site hazardous waste management activity, their distributional differences become obvious. The average commercial treatment facility had only one-tenth the total capacity of the average on-site treatment facility. Commercial disposal was only a quarter as big and storage only half as big as the average on-site disposal and storage facilities. These comparisons are heavily influenced, however, by the few, very large, on-site facilities. On average, commercial management facilities are larger than the on-site facilities, even though the few very large facilities tend to be on site. The typical (median) commercial treatment facility was five times larger than the typical

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[4] Ignoring the largest storage facility that was assumed to be at full capacity, the average facility storage rate was also higher than the cumulative capacity utilization rate.

Table 24. Distributions of Unused Capacity Over Facilities for Treatment, Storage and Disposal of Hazardous Waste

Unused Treatment Capacity (gallons)	Cum. % of TSD Facil.*	Unused Storage Capacity (gallons)	Cum. % of TSD Facil.*	Unused Disposal Capacity (gallons)	Cum. % of TSD Facil.*
0	13	0	20	0	20
12,000	25	610	25	9,800	25
150,000	50	9,800	50	1,300,000	50
4,600,000	75	74,000	75	21,000,000	75
81,000,000	90	840,000	90	200,000,000	90
8,000,000,000	100	2,100,000,000**	100	560,000,000	100

*This percentage of facilities had less than the number of gallons of unused capacity shown to the left.

**The unused storage capacity of the largest storage facility (representing 12.4 billion gallons) was undetermined, but could be much larger than this amount.

on-site treatment facility, and commercial disposal and storage were 3 and 33 times larger respectively.

A final difference between commercial and on-site hazardous waste management capacity is that the commercial capacity focuses primarily on disposal while the on-site capacity is mostly for treatment. This can be observed in Table 23.

8.2 Regional Utilization of Existing Capacity

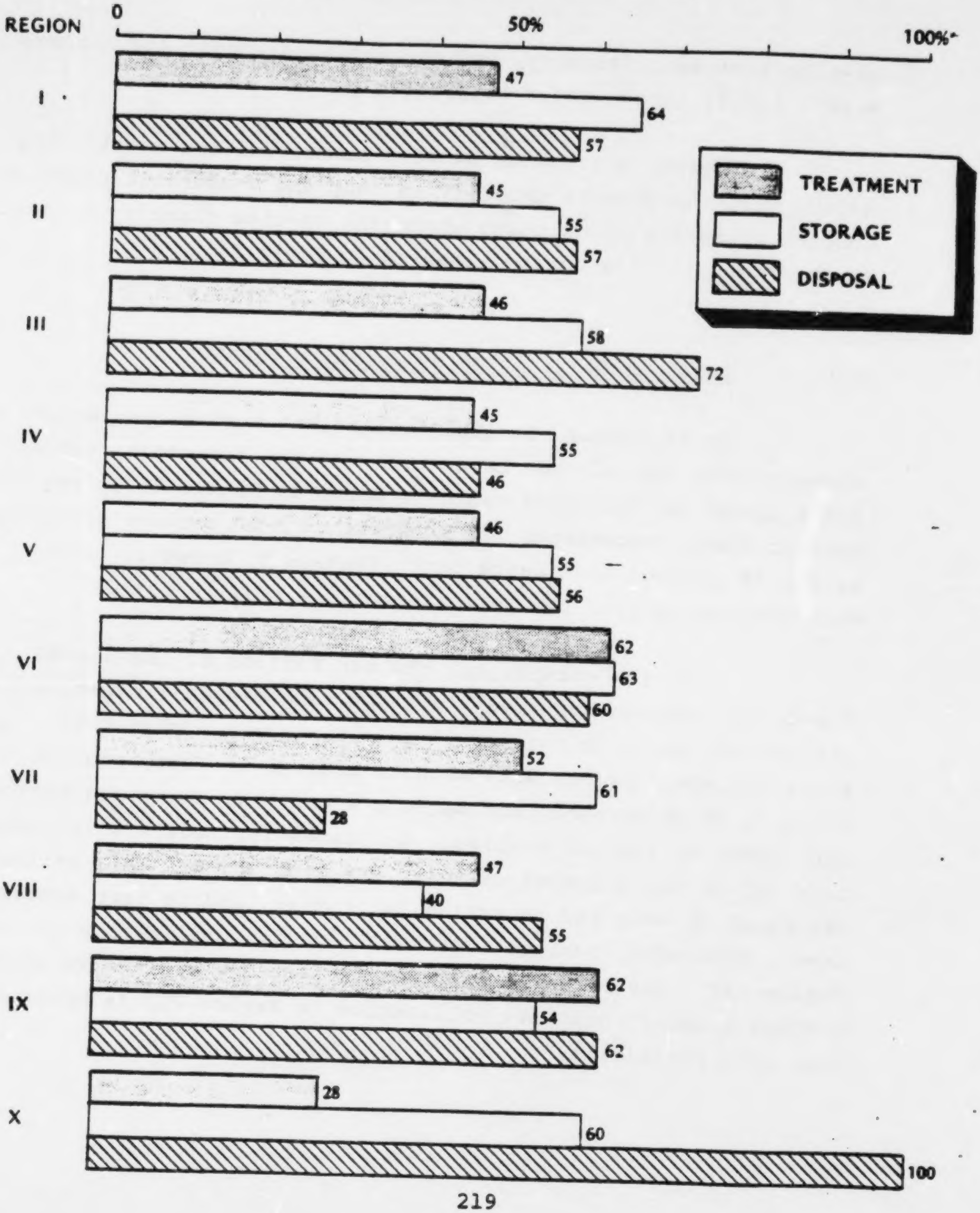
As of January 1, 1982 facilities' average percentage of capacity that was already being used for the treatment, storage and disposal of hazardous waste is shown in Figure 35 by region. Most of these percentages are accurate to ± 10 percent or better at the 95 percent confidence level (Region X, however, with a much smaller sample, had less accuracy -- i.e., ± 20%).

With few exceptions, the ten regions of the United States had average treatment, storage, and disposal capacity utilization rates of between 45 and 65 percent during 1981. Exceptions include: Region VIII with an average facility storage capacity of 40 percent, and Regions X and VII, where the estimates were based on limited samples. Estimates for Region X indicate that all of the disposal capacity was used up, but this estimate was based on only two reporting facilities, and is very approximate. Similarly, average treatment capacity utilization for this region (28%) was based on only six facilities, and the 28 percent average disposal capacity utilization in Region VII is based on only five facilities.

Figure 35

1981 AVERAGE FACILITY TSD CAPACITY UTILIZATION RATES, BY REGION

Average Percentage of Capacity Utilized in 1981



8.3 Unused Capacity by Region

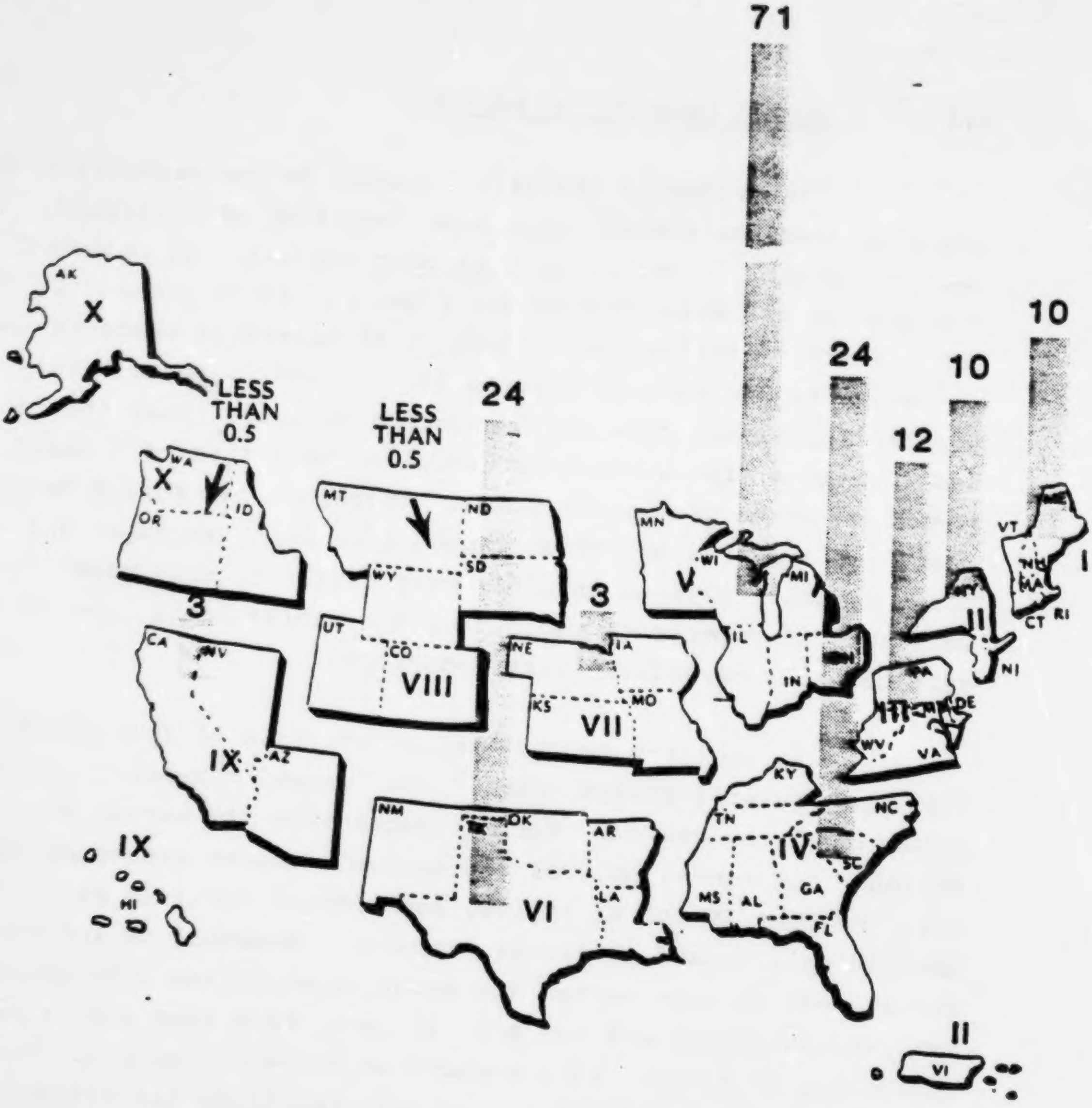
The preceding analysis focussed on the proportion of capacity that has already been used (capacity utilization). This section focuses attention on remaining capacity, as measured in billions of gallons. The unused capacity, as of January 1, 1982, for treating, storing, and disposing of hazardous waste is shown by region in the maps of Figures 36, 37, and 38 respectively. Nationally, almost none of this unused capacity (less than 2%) was located at facilities that received more than half their hazardous waste from other firms. Therefore, it should be noted that even though substantial unused treatment, storage, and disposal capacity existed in 1981, very little of this capacity was available at commercial facilities and public facilities that service other hazardous waste generators.

In contrast to the earlier analysis of "average facility capacity utilization rates," the "unused capacity" varies dramatically by region. The estimates from the survey show that Region V has almost half of the nation's unused treatment capacity. Regions IV and VI follow, each having about 15 percent of the nation's unused treatment capacity. However, as indicated above, most of this unused treatment capacity was located at captive facilities and may not, in fact, have been available to generators at large. As was shown in Table 24, much of this unused capacity was located at a very few large facilities.

Unused storage and disposal capacity was also highly concentrated in certain regions. Over three-quarters of the nation's unused storage capacity was located in Regions II and VI, while nearly 60 percent of the nation's disposal capacity was located in Region IV. Another quarter of the total disposal capacity was also located in Region VI.

Figure 36

1981 REGIONAL UNUSED TREATMENT CAPACITY
(billions of gallons)

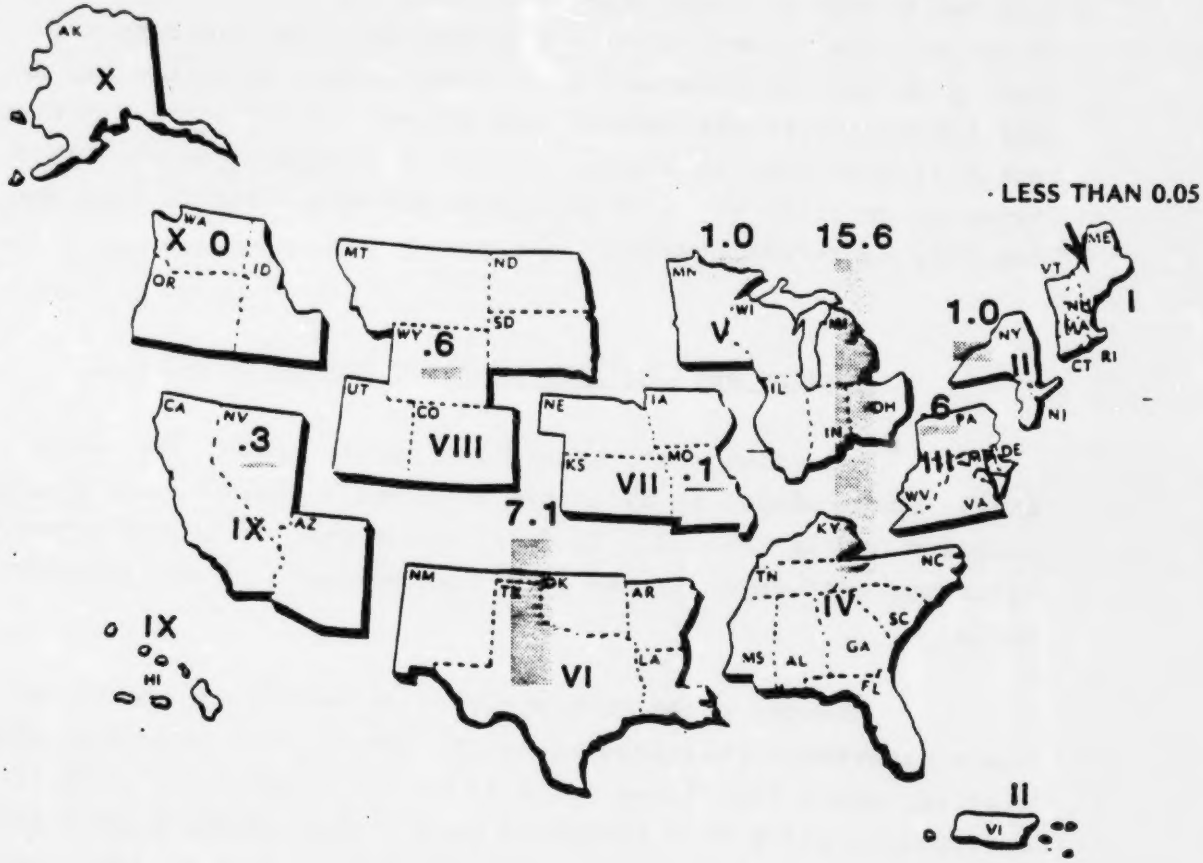


71
10
24
10
12
LESS THAN 0.5
LESS THAN 0.5
24
3
3
X
AK
WA
OR
ID
MT
ND
SD
WY
UT
CO
VIII
CA
NV
AZ
IX
NE
IA
KS
MO
VII
MN
WI
MI
IL
IN
OH
V
NY
II
NJ
PA
DE
MD
WV
VA
III
VT
NH
ME
MA
CT
RI
I
KY
NC
TN
SC
GA
AL
MS
FL
IV
NM
TX
OK
AR
LA
VI
IX
HI
II
VI

TOTAL U.S. UNUSED TREATMENT CAPACITY = 158 Billion gallons (587 Million metric tonnes)

Figure 38

1981 REGIONAL UNUSED DISPOSAL CAPACITY
(billions of gallons)



AK
X
LESS THAN 0.05
WA
X 0
OR
ID
MT
ND
SD
WY
.6
UT
CO
VIII
CA
NV
.3
IX
AZ
IX
HI
1.0
MN
WI
V
15.6
MI
IL
IN
OH
NE
IA
KS
MO
VII
.1
7.1
NM
TX
OK
AR
LA
VI
KY
TN
NC
SC
IV
GA
MS
AL
FL
1.0
NY
II
NJ
.6
PA
III
MD
DE
WV
VA
VT
ME
NH
MA
I
CT
RI
II
VI

TOTAL U.S. UNUSED DISPOSAL CAPACITY = 26.3 Billion gallons (98 Million metric tonnes)

Again, readers are cautioned that these figures are estimates, as of January 1, 1982, and subject to change. In the past two years it is to be expected that some of this capacity has been used up, and that some new capacity has been created; the net effect of these changes in 1982 and 1983 is beyond the scope of this present study. Furthermore, some capacity currently in use for treatment or storage (e.g., in tanks) may be emptied as stocks are reduced and thereby become available once again as treatment or storage capacity in future years. Other types of capacity are more nearly fixed (e.g., landfills), where capacity decreases steadily with use.

8.4 Summary and Conclusions About Available Capacity

Hazardous waste generation levels during 1981 were easily accommodated by available treatment, storage, and disposal capacity across the U.S. In fact, the amount of unused capacity indicates that capacity was more than adequate on an aggregate basis.

Changes could have occurred in generation rates and waste management practices since the survey. If capacity becomes limited, small facilities could be more vulnerable to capacity constraints since they tended to have higher capacity utilization rates. Commercial facilities may be able to ease a tight capacity situation, but their quantities represent such a small part of the overall hazardous waste management system that on-site facilities would have to accommodate most of the additional demands From the 1981 survey data, however, it appears unlikely that a capacity crisis is on the horizon.

PART V (Section 9)

FUTURE STUDIES

9. NEXT STEPS: FUTURE HAZARDOUS WASTE STUDIES

The National Survey of Hazardous Waste Generators and Treatment, Storage, and Disposal Facilities regulated under RCRA during 1981 was designed to meet a variety of EPA's information needs in the hazardous waste management field. While its scope was broad, creating more than 6,000 individual statistical data elements, it was never intended to meet all of the Agency's growing information needs in this critical issue area. The survey is seen as providing EPA with baseline data on the nature and scope of hazardous waste generation and management activities regulated under RCRA, the first reliable data of this nature to be made available since enactment of RCRA by Congress in 1976.

The national survey was not designed to provide detailed information in a number of areas. Examples include: distinguishing the specific quantities associated with individual constituents in mixtures of hazardous wastes and mixtures of hazardous waste and nonhazardous wastes; determining the numbers of sites operating exempt wastewater treatment systems; and estimating the quantities of hazardous wastes that are managed in exempt processes. Followup efforts to this survey would be required to provide the detailed information necessary in these and other areas.

In addition to questions arising from analysis of the mail survey data, EPA faces increasing information needs in a number of issue areas related to the Agency's continuing development of the RCRA hazardous waste regulatory program. Detailed information is now required on specific hazardous wastes and hazardous waste management activities, including many currently outside the scope of existing RCRA regulations.

The purpose of this section is to provide a brief overview of major hazardous waste information collection efforts currently being conducted or to be conducted in the near future by EPA. In conjunction with the data obtained through the mail survey, these information collection activities are designed to provide EPA with necessary information for development of regulations and standards required under RCRA to assure protection of human health and the environment in the generation and management of hazardous waste.

9.1 Mail Survey Followup Activities

Several of the information needs left unsatisfied by the mail survey have been receiving increased attention since the release of preliminary findings from the mail survey in August of 1983. Most prominent among these are those related to quantities of hazardous waste affected by the mixture rule and quantities of hazardous waste managed in processes currently exempt from regulation under RCRA. In coming months, EPA's Office of Solid Waste will be undertaking a number of efforts to try to resolve these issues. These efforts will in all likelihood involve two tracks:

- Conducting more detailed, sophisticated analyses of existing data obtained through the survey questionnaires, including an examination of the "hard copy" versions of the questionnaires themselves; and,
- Designing and implementing followup information collection devices capable of providing greater detail in the areas left ambiguous or with insufficient detail in the survey.

OSW expects these efforts to continue through the current calendar year, although specific time frames for completion have not yet been established.

9.2 Updates and Expansions to Mail Survey Data Base

OSW will update the mail survey data base over time as continuing analyses encounter additional respondent and/or data processing errors that have avoided detection to date despite the extensive data editing which has been conducted. In addition, OSW is continually exploring ways of expanding the data base through the acquisition of additional data. Existing data sources that can be targeted to individual sampled generators and facilities will be identified and efforts made to acquire access to the data contained therein. Finally, as additional data are obtained through other studies, they will be stored, whenever possible, in such a way as to allow for comparison with mail survey data.

9.3 Continuing Analysis of Mail Survey Data

While this report summarizes some of the major findings in the data obtained from the mail survey, it generally limits itself to population-wide estimates. A wealth of data, more than 6,000 statistical data elements, were obtained through the survey, however. Separate questionnaires were developed for each process used to manage hazardous wastes under RCRA. Data relating to facility design and operating characteristics, costs and prices associated with waste management operations, and process-specific capacities all await analysis by OSW, and outside parties ranging from Congressional committees to individual members of the public. An extensive description of the computer data base developed through the survey is presented in Appendix D. Mail survey data are expected to provide a basis for the development of numerous reports by EPA and its contractors on specific hazardous waste management issues over the coming year.

9.4 Small Quantity Generators Study

EPA is currently in the middle of a two-year, in-depth analysis of alternative methods of regulating small quantity generators of hazardous waste. Small quantity generators, defined in Section 6, include such small businesses as gasoline service stations, auto repair shops, dry cleaners, schools, amusement parks, and others. The study, begun in late 1982, is designed to evaluate the environmental problems posed by small quantity generators. It will analyze the types and quantities of wastes generated by these firms, their current waste management practices, and various strategies for controlling hazardous waste generated by these small quantity generators. The study was prompted, in part, by Congressional proposals to reduce or eliminate the small quantity generator exemptions currently in effect in EPA's RCRA hazardous waste regulatory program.

The study involves an extensive survey of firms believed to be small quantity generators. Also involved is an assessment of state experiences in regulating small quantity generators, through a series of case studies. Survey forms were mailed to firms in the fall of 1983. Data from the survey are expected to be compiled by mid-summer of 1984; the state case studies are expected to be completed by the end of the summer. EPA expects to issue regulatory proposals by May of 1985, with final rules promulgated in 1986.

9.5 Survey of Used Oil and Waste-Derived Fuel Material

OSW is conducting a survey to collect economic and technical information from facilities that handled (collected, purchased, processed, transported, sold, stored) or burned used oils or waste-derived fuel materials during 1982 and 1983. The obtained information will be used for regulatory development purposes and to support regulatory impact analyses. Information is being collected in two stages: Track 1, now completed, generated data on approximately 450 handlers and 100 burners using two detailed, full length questionnaires. Track 2, ongoing, will develop more representative data from burners by first characterizing the universe of potential burners (using a one-page "short questionnaire"), and then targeting facilities that burn "waste-derived fuels" for the completion of a more detailed questionnaire to obtain their 1983 data. Track 2 is expected to be completed in the spring-summer of 1984.

9.6 Industry Studies

EPA's Office of Solid Waste has been engaged in an ongoing series of industry studies, which involve detailed evaluations of the wastes generated by specific industries. These studies, which are expected to continue indefinitely, are designed to support EPA's decisionmaking process and the justification for listing and not listing specific industrial wastes as hazardous wastes, pursuant to requirements contained in Congressional proposals for amendments to RCRA. The studies entail engineering analyses of each industry's production processes, site visits to confirm the engineering analyses, use of industry-specific questionnaires for data gathering, and verification and evaluation of the data gathered from all these sources.

Industries that these studies have focused on to date include: Dyes and Pigments; Industrial Organics; Chlorinated Organics (Chlorinated Aliphates); Pesticides; Plastics and Resins; Organobromines; Rubber Processing Compounds; and Petroleum

Refining. A number of listing proposals resulting from studies completed to date are currently being finalized. Listing proposals are expected to be issued periodically throughout the duration of the industry studies project.

9.7 RCRA Biennial Report

The Office of Solid Waste is anticipating a legislative requirement to submit a report to Congress by March 31, 1985, describing nationwide hazardous waste generation, treatment, storage, and disposal during the 1983 calendar year. This report will be based on data collected pursuant to the RCRA biennial reporting requirements of Sections 3002 and 3004 of RCRA.

Under the requirements of 40 CFR 262.41, 264.75, and 265.75, hazardous waste handlers located in States that do not have any form of authorization as of March 1, 1984, are required to submit a biennial report to EPA by that date. Authorized States must have substantially equivalent reporting requirements and are required to submit aggregated data to EPA from their analogs to the RCRA biennial report.

EPA intends to modify the Hazardous Waste Data Management System (HWDMS) to aggregate the data collected from handlers in unauthorized States through its biennial report. In addition, EPA will be receiving aggregated data from the authorized States by September 30, 1984. Aggregated data from both authorized and unauthorized States will be loaded into a data base during the late fall of 1984 to permit manipulation of State by State data to produce a nationwide report on hazardous waste management during the 1985 calendar year. This report is scheduled to be completed and transmitted to Congress by March 31, 1985.

These future studies are summarized in Figure 39 on the following page. More detailed information regarding these studies can be obtained by contacting the Office of Solid Waste.

Figure 39

FUTURE STUDIES

Mail Survey Followup

A. Design, identify gaps, and uncertainties . . Spring 1983

- Develop methodology and design data gathering plan

B. Implement design and report on revised estimates . . . Spring 1985

Special Analyses by Process Type 1984-85

Ongoing Data Base Update 1984-85

Small Quantity Generators National Survey

- **Survey data compiled . . . . Summer 1984**
- **State case studies completed . . . . Fall 1984**
- **Regulatory proposals . . . . Summer 1985**

Waste as a Fuel

- **Track 1 completed . . . . Fall 1983**
- **Track 2 completed . . . . Spring-Summer 1984**

Industry Studies . . . . Ongoing

Analyses of RCRA Annual Reports

- **Reports submitted from handlers . . . . . . Winter 1984**
- **State summaries to EPA . . . . Fall 1984**
- **EPA summary report . . . . Winter 1985**

APPENDICES

APPENDIX A

SAMPLE DESIGN AND STATISTICAL RELIABILITY

This study actually involved 10 different sample designs, one for each of the following type of hazardous waste handlers:

- Generators;
- Injection Wells;
- Landfills;
- Land Treatment;
- Surface Impoundment;
- Waste Pile;
- Incinerators;
- Storage Containers;
- Storage Tanks; and
- Treatment Tanks.

A brief summary of the sample design features is presented below. A more detailed description is provided in Westat's separate report to EPA.

A.1 Stratification

To enhance the representativeness of the samples of TSD facilities, they were stratified by several variables. These stratification variables were: EPA region, whether hazardous waste was also generated at the site at which it was being managed, and, when available, by an approximate measure of size (quantity of hazardous waste managed).

For the sample of generators, the population of generators was divided into three sets of strata based on primary SIC code. This was done in order to sample some industries more heavily than others. The three SIC groups are presented below:

The Three SIC Strata

Group 1

1. 2491
2. 2812
3. 2816
4. 2861
5. 2892
6. 2992
7. 3351
8. 3356

Group 2

1. 0700-0799
2. 2600-2699
3. 2860-2869 (except 2861)
4. 2879
5. 2911
6. 3310-3319
7. 3341
8. 3471
9. 3479
10. 3711
11. 3714
12. 4953

Group 3

1. All remaining SIC codes not accounted for in strata 1 and 2

These strata were sampled at varying rates, depending on whether they were found on the Notifier file only; also on the Part A file, but not confirmed as having TSD facilities by the telephone survey, or on the Part A file and confirmed as having TSD facilities by the telephone survey. Thus, there were nine major generator strata. Each of these strata were further stratified by three other variables: four digit primary SIC code; within SIC code, by region; within region, by a size measure (number of employees or a quantity measure depending on the stratum) when available.

A.2 Sampling Method

Most lists were systematically sampled in order to achieve increased precision for estimates of facility percentage characteristics (e.g., what percent of landfills are lined?). Oversampling of selected strata was not used, except for certain generator SIC codes of special regulatory interest to EPA. The size of the selected sample was designed to be larger than the expected number of completes by a sufficient margin to allow for nonresponse and ineligibles. A pre-survey telephone verification effort was used to more accurately anticipate nonreponse and ineligibility rates.

A.3 Precision

The sample design produced estimates with precision limits of from ±5 percent to ±11 percent at the 95 percent confidence level for percentages of facilities with particular characteristics for each of the various treatment, storage, and disposal (TSD) facility samples. Variance estimates for specific questionnaire items were made by half-sample and paired-difference techniques, since standard statistical programs (e.g., SAS, SPSS) assume simple random samples and neglect the payoff of the finite population correction factor and stratification. Particularly for the smaller universes (such as land treatment facilities and injection wells), the finite population correction adjustment makes an important contribution to the reduction of the estimated variance.

The precision bounds for estimated percentages obtained with 95 percent confidence (from ±5% to ±11% for the individual process types, ±2.4% for generators, and ±3.0% for the TSD General Questionnaire) were established using the following expression. In general, the bound b was determined by

$$b = (2)\ 100 \sqrt{1 - \frac{n}{N}} \sqrt{\frac{p\,q}{n}}$$

where

n = the number of respondents to a questionnaire
N = the estimated size for the universe in question
p = the proportion of sites with a particular characteristic, taken to be .5
q = 1 - p.

The value "2" in the equation was a rounding of "1.96," the value obtained from a normal distribution table associated with achieving 95 percent confidence. The proportion p was chosen to take on a value of .5 in order to obtain a conservative estimate of precision. That is, the confidence limits may be wider than needed for 95 percent confidence. If the estimate p were .3 rather than .5, the width of the confidence interval would actually be 92 percent of that presented in this report. Thus, a data analyst may find it beneficial to compute the actual confidence limits rather than use the general limits for percentages presented in this report.

In the cases of the Tank and TSD Questionnaires, an additional factor must be multiplied times the value of b expressed above to obtain limits of precision. This is necessary because the sites sampled to receive these questionnaires were selected with varying probabilities. The factors are the square root of the design effects, and allow the limits b' to be obtained for tanks on the TSD General Questionnaire. Specifically, the limits are:

Limits for Tanks and TSD General

Tanks	$b' = 1.06b$
TSD General	$b' = 1.39b$

where b is obtained as indicated previously.

The bounds obtained for generators were computed based on a stratified estimate of variance. A description is provided in Westat's more detailed report.

A.4 Weighting

Base weights were determined as the inverse of probabilities of selection. These weights were adjusted for nonresponse within broad industry groups for each sample. Thus, differential cooperation rates by different industries were taken into account. The base weights for Tanks and the TSD General Questionnaire reflect the fact that the sampled sites had multiple opportunities of selection if they appeared on more than one sample frame list. For example, a site found on the incinerator, landfill, and waste pile sample frames had three different opportunities to be selected and receive a TSD General Questionnaire. Finally, minor weight adjustments were made to reconcile national estimates of the total number of process facilities obtained from the individual process type component samples with those obtained from the TSD General Questionnaire.

Table A-1 summarizes the major sampling information associated with this survey. This includes precision levels for various estimates, and types of estimates and the average sampling weight associated with each questionnaire sample. These weights are essentially constant except for the Tank, Generator, and TSD General Questionnaires, as noted in the footnote.

Table A-1. Summary of Statistical Aspects of the TSD and Generator Surveys

Sample	Stratified by	Average Weight*	Estimated size 1981	Sample Size (Number of Respondents Active in 1981)	Precision at the 95% Confidence Level: For "Percentage of Facilities" Estimates***	Precision at the 95% Confidence Level: For a General "Quantity" Estimate
Generators	SIC Group-4 Digit SIC Code-Region-Number of Employees at Location	6.76	14,098	2,084	± 2.4%	± 80%
TSD General	-----	3.30	4,818	1,462	± 3.0%	± 49%
Injection Wells	Region-Generator-Quantity	1.20	87	73	± 4.8%	± 16%
Landfills	Region-Generator-Quantity	2.52	199	79	± 8.7%	± 54%
Land Treatment	Region-Generator Quantity	1.88	70	37	± 11.3%	± 32%
Surface Impoundments	Region-Generator Quantity	5.23	764	145	± 7.5%	± 40%(Treated) ± 64%(Stored) ± 172%(Disposed)
Waste Piles	Region-Generator Quantity	2.39	174	73	± 8.9%	± 52%
Incinerators	Region-Generator-Quantity	1.92	240	117**	± 6.6%	± 28%
Storage Containers	Region-Generator-Quantity	18.73	3,577	191	± 7.2%	± 50%
Storage Tanks	Region-Generator-Quantity	6.11	1,428	233	± 6.4%	± 112%
Treatment Tanks	Region-Generator-Quantity	5.03	609	121	± 8.6%	± 86%

---

* The weight was essentially constant within a sample except for the tanks, generators, and the TSD general components. The range of weights for these samples were: tanks, 4.1 to 10.6; generators, 1 to 19.0; and TSD general, 1.1 to 25.0.

** For incinerators, there were eight additional respondents who were not active in 1981 but were eligible to complete the questionnaire.

*** Bas[illegible] an [illegible]imat [illegible] rop[illegible] n o[illegible]

APPENDIX B
FIELD REPORT

B.1 Field Period

This survey of hazardous waste handlers was conducted by Westat, Inc., for the Environmental Protection Agency's Office of Solid Waste (OSW) in the fall of 1982. It is the most extensive data collection effort on hazardous waste management practices to date. The survey was national in scope, covering the fifty states as well as U.S. Territories. Preparatory work for the survey actually began in 1981, when Westat began working with EPA/OSW on the development of annual survey forms for hazardous waste generators, and for hazardous waste treaters, storers and disposers. While these forms were being prepared, the need became apparent for additional information on treatment, storage and disposal technologies and for more detailed information about hazardous waste generators and hazardous waste treaters, storers and disposers.

Also in preparation for the mail survey, Westat conducted telephone status verification interviews with approximately 9,000 treatment, storage and disposal facilities that filed RCRA Part A Applications stating that they intended to manage hazardous waste. These telephone interviews were conducted in two phases during the spring and summer of 1982 in an attempt to verify the processes used by the facilities to manage hazardous waste in 1981. The results provided a sampling frame for the selection of facilities to receive the RIA mail survey questionnaire, and are summarized in the "Report on the Telephone Verification Survey of Hazardous Treatment, Storage, and Disposal Facilities Regulated Under RCRA in 1981," produced by Westat in November, 1982.

B.1.1 Questionnaire Preparation and Pretest

The two original annual survey forms were expanded into a Generator Questionnaire; a Treatment, Storage and Disposal General Questionnaire; and eight process-specific Management Technology Questionnaires to serve Regulatory Impact Analysis (RIA) data needs. With ongoing interaction with each RIA group, the questionnaires went through numerous draft versions. The questionnaires were submitted to OMB for review and received clearance just before the mailout in September.

In June of 1982, questionnaires were mailed to a pretest group including associations and other groups concerned with hazardous waste management. Returned questionnaires were examined by EPA staff and by Westat questionnaire designers to determine the efficiency of the instrument in gathering data. Each of the 10 questionnaires underwent many revisions in the month of August.

B.1.2 Mailout

The mailout was a complicated time-consuming task because of the large number of packages to be mailed, because each TSD facility received a "custom" package with different components, and because the packages were sent certified mail. Approximately 15 full-time equivalents were required to complete the mailout in two weeks. The mailout was completed September 17, 1982. Packages containing Generator Questionnaires were mailed to a sample of 10,667 generator installations. The sample was drawn from EPA's computer file of Notification forms, which had been submitted by firms that indicated they were or would be generators of hazardous waste, but that did not file Part A Applications with EPA to treat, store, or dispose of hazardous waste on site. In addition, 2,599 packages containing Treatment, Storage, and Disposal General Questionnaires and one or more of nine process-specific management technology component questionnaires, including the Generator Questionnaire, were mailed to facilities sampled from Westat's Part A/Verification computer file. (This computer file was developed from the data collected in the Telephone Verification Survey described in Section B.1, above.)

Because the packages were sent by certified mail, we were able to determine when the package was received and who received it. The letter which accompanied the questionnaires stated the RCRA regulation that respondents had 45 days from the date they received the questionnaire in which to reply. By tracking the certified card date on Westat's Automated Receipt Control System (discussed below), it was possible to followup each respondent on the 45th day after the package was received. The letter also advised respondents that it was possible to obtain official time extensions. Numerous time extensions were requested and were granted by EPA (see Section B.4.3).

Based on return rate and sample sizes needed for analysis, decisions to extend the cut-off date for returns extended the date from November 15 to December 15, 1982 and finally to (postmarked) February 1, 1983. To increase response rate during this period, several steps were taken:

- Followup calls were made to TSD's three days after 45-day limit;

- Two series of individualized followup letters were sent to TSD's and to generators (see Section B.2.2.1); and
- Technical assistance was provided to respondents by Westat and EPA telephone hotlines.

Returns were tracked by an automated receipt control system. Each day, certified cards and returned questionnaires were keyed into the system. Reports were produced by the system on a weekly basis. Since the system tracked returns by questionnaire type as well as by site, we could follow up on cases where not all questionnaires were returned as well as on cases where no response was received at all. In addition, the system was used to produce summary statistics that were submitted weekly to EPA. Examples of these reports appear as Exhibits B-1 through B-3.

Figure B-1 presents the number of responses by month for TSD facilities. Figure B-2 presents the number of responses, by month, for generators. As can be seen from these figures, the followup efforts, which were conducted after the end of November, yielded a substantial number of responses, especially for TSD facilities, where high response rates were the most critical because of small sample sizes for certain sample strata.

Exhibit B-1. Example of Automated Receipt Control System Weekly Report -- TSD Facility Return Status by Region

RIA Mail Survey Receipt Control Status Report!
TSD Facilities (All components combined)

12/23/82

Facility Status	EPA Region 1	2	3	4	5	6	7	8	9	10	U.S. Total
Status Known!	189	320	296	368	560	401	83	61	241	59	2545
o Package Accepted!	187	317	296	366	553	391	82	54	234	56	2476
- Response Recieved!	155	273	229	320	466	336	72	49	179	43	2114
o All components returned!	152	268	219	315	460	329	72	44	173	42	2070
- All components applicable	84	136	124	169	223	183	40	24	78	18	1077
- Some components not applicable	49	91	71	85	126	70	20	15	58	6	591
- No components applicable	19	41	24	61	111	72	12	5	37	18	400
o Some components not returned	3	5	6	5	6	11	0	1	6	1	44
- Time Extension granted	1	3	3	2	9	8	1	0	16	1	44
- Response Anticipated	27	39	23	40	60	43	8	7	33	12	296
- Response Not Anticipated!	4	6	5	4	10	4	1	2	6	0	42
o Facility closed	4	6	4	4	10	3	1	2	6	0	40
o Facility refuses to respond	0	0	1	0	0	1	0	0	0	0	2
o Package Undeliverable	2	3	0	2	15	10	1	7	7	3	50
Status Unknown	0	1	1	2	1	4	0	0	2	0	11
TOTAL IN SAMPLE	189	321	297	370	569	405	83	61	243	59	2557

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Exhibit B-2. Example of Automated Receipt Control System Weekly Report -- TSD Facility Return Status by Questionnaire Type

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                         RIA Mail Survey Receipt Control Status Report!
                                        TSD Components

                                           12/23/82

+----------------------------------------------+-------------------------------------------------------------+
|                                              |                  Questionnaire Component                    |
|               Facility Status                |  IW    LF    LT    SI    WP    IN    CN    TK    GN    TG  |
+----------------------------------------------+-------------------------------------------------------------+
|                                              |                                                             |
| Status Known!................................|  114   202   79   326   242   264   420   842   550   2546|
|                                              |                                                             |
|    o Package Accepted!.......................|  111   197   78   325   235   258   412   823   541   2496|
|                                              |                                                             |
|         - Response Recieved!..................|   84   146   63   278   189   202   352   696   486   2098|
|                                              |                                                             |
|                    - Component applicable.....|   59    70   24   146    70   128   301   491   390   1396|
|                    - Component not applicable.|   25    76   39   130   118    72    51   201    94    686|
|                    - Applicability not determined....|    0     0    0     0     0     1     0     0     0      1|
|                    - Component not rtrnd w/ response.|    0     0    0     2     1     1     0     4     2     15|
|                                              |                                                             |
|         - Time Extension granted..............|    4     7    1     4    11     8     4    13     4     46|
|                                              |                                                             |
|         - Response Anticipated................|   20    38   10    33    25    38    53    98    46    298|
|                                              |                                                             |
|         - Response Not Anticipated!...........|    3     6    4    10    10    10     3    16     5     54|
|                                              |                                                             |
|                 o Facility closed.............|    1     5    4     9    10     9     3    15     5     52|
|                 o Facility refuses to respond.|    2     1    0     1     0     1     0     1     0      2|
|                                              |                                                             |
|    o Package Undeliverable...................|    3     5    1     1     7     6     8    19     9     50|
|                                              |                                                             |
| Status Unknown...............................|    1     0    1     1     1     1     3     5     3     11|
|                                              |                                                             |
+----------------------------------------------+-------------------------------------------------------------+
|                                              |                                                             |
|               TOTAL IN SAMPLE                |  115   202   80   327   243   265   423   847   553   2557|
|                                              |                                                             |
+----------------------------------------------+-------------------------------------------------------------+
```

Exhibit B-3. Example of Automated Receipt Control System Weekly Report -- Generation Installation Return Status by Region

RIA Mail Survey Receipt Control Status Report!
Off-Site Generators

12/23/82

Facility Status	EPA Region 1	2	3	4	5	6	7	8	9	10	U.S. Total
Status Known!....................................	862	1001	953	1286	2463	1504	475	336	1293	349	10502
o Package Accepted!............................	815	954	873	1225	2327	1478	465	333	1257	345	10072
- Response Recieved!..........................	593	639	638	1023	1064	1285	380	276	1044	291	8033
o Components applicable.............	224	238	203	263	657	184	140	53	349	76	2387
o Components not applicable........	369	399	434	760	1200	1098	240	222	695	214	5831
o Applicability not determined....	0	2	1	0	7	3	0	1	0	1	15
o Component not rtrnd w/ response.	0	0	0	0	0	0	0	0	0	0	0
- Time Extension granted.....................	15	21	31	40	39	35	8	4	12	5	210
- Response Anticipated........................	194	200	197	138	407	191	74	48	109	44	1722
- Response Not Anticipated!..................	13	14	7	16	17	7	3	5	12	5	99
o Facility closed............................	13	14	7	16	17	7	3	5	12	5	99
o Facility refuses to respond..........	0	0	0	0	0	0	0	0	0	0	0
o Package Undeliverable........................	47	127	80	61	136	26	10	3	36	4	330
Status Unknown....................................	5	10	1	5	19	5	1	3	10	6	65
TOTAL IN SAMPLE	867	1091	954	1291	2482	1509	476	339	1303	355	10667

Figure B-1 TSD Questionnaire returns by end of each month from September 17, 1983 mailout. RCRA required return date: November 15. 2,599 packages mailed.

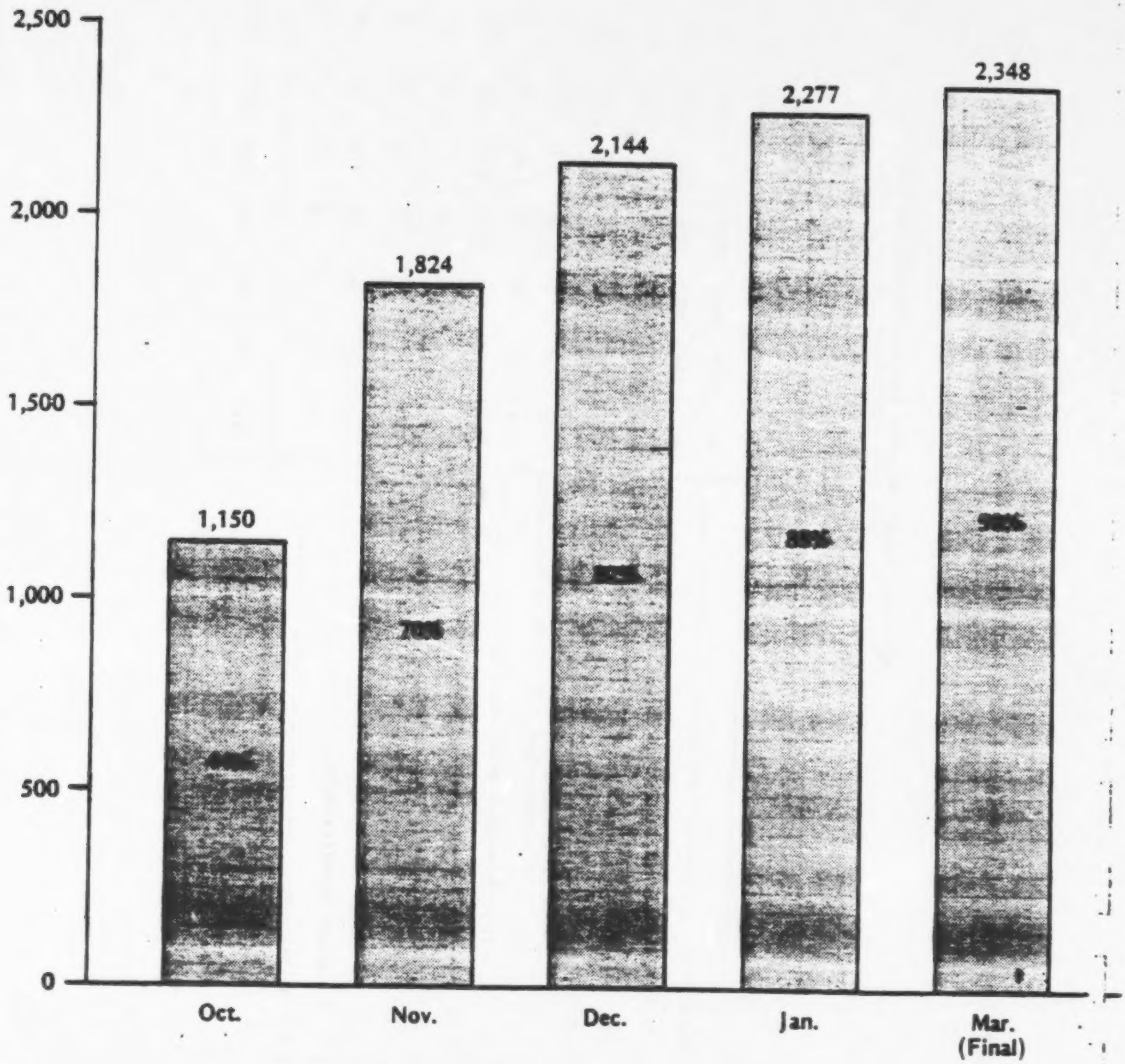
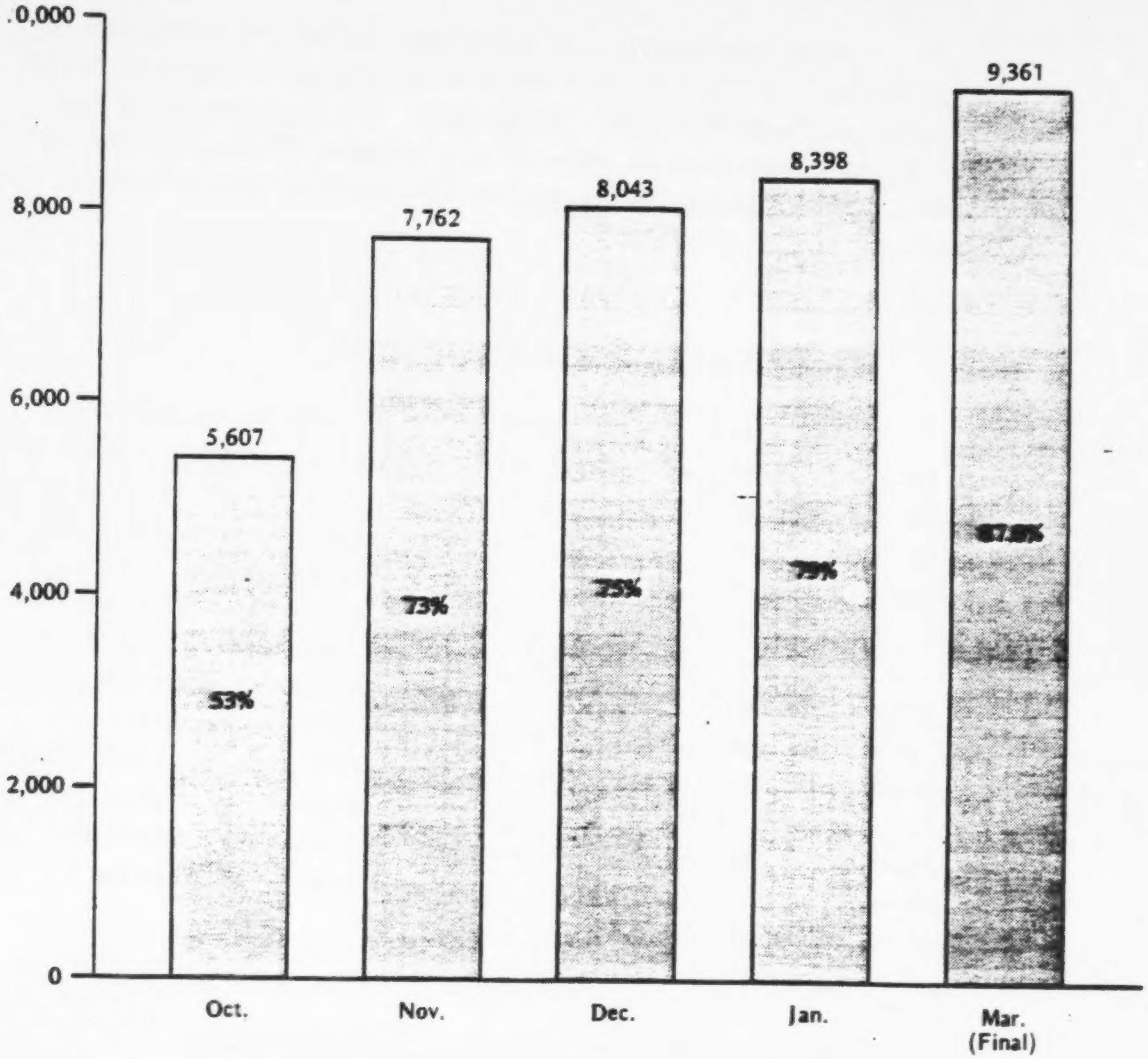


Figure B-2 Notifier Generator returns by end of each month from September 17, 1983 mailout. RCRA required return date: November 15. 10,667 packages mailed.



B.2 Production Statistics

Production statistics were kept using the automated (computerized) receipt control system described in Section B.1.2 and below in Section B.2.2. In general, the response rate for each of the questionnaire samples was between 85 percent and 93 percent. The eligibility rates for the samples ranged between 19 percent and 73 percent.

B.2.1 Definitions of Return Status Groups

The return status for each mailed out questionnaire was recorded on the automated receipt control system. The return status was initialized (or assigned) with the status code INIT at the time of mailout, which indicated that the questionnaire package had been mailed out but no response had been received. Since the questionnaires were all mailed using certified mail service, when the certified mail card was returned by the facility the return status for the facility was updated to CERT, to indicate positive evidence of contact with the facility. Returned questionnaires were scan-edited as they were received, and given return statuses of CMPL, indicating a completed, eligible response and INEL, indicating a returned ineligible response. A complete list of return status codes and their definitions is provided below in Figure B-3.

B.2.2 Response Rate for Generator Questionnaires

Installations sampled from the HWDMS Notifier file were assumed to be generators of hazardous waste who managed their wastes off site, since these installations had notified EPA of their intent to generate hazardous waste but had not

Figure B-3 Return Status Codes and Definitions

Return Code	Return Status	Definition
CMPL	Complete	Completed, eligible questionnaire received (facility was engaged in regulated activity covered by the questionnaire)
INEL	Ineligible	Ineligible questionnaire received (facility was not engaged in regulated activity covered by the questionnaire)
Non-Response Categories:		
INIT	No contact	Questionnaire mailed, but certified mail card was not returned
NDEL	Not deliverable	Questionnaire mailout package could not be delivered by the Post Office (repeated attempts using alternative addresses were made)
CERT	Certified Mail	Certified mail card received. As a final return status, this means there is positive evidence that facility received the questionnaire, but did not respond.
PEND	Time extension granted	A time extension beyond the allowed 45 days was granted. As a final return status, this means facility did not respond after requesting and being granted a time extension.
MISS	Questionnaire missing from respondent's returned package	Facility returned at least one, but not all of the questionnaires it was sent. This return status applied only to TSD facilities, which always received two or more questionnaires.
REFS	Refused	Facility refused to complete questionnaire.
CLOS	Closed	Facility closed after January 1, 1981. (Records or personnel were not available.)
OTH	Other nonresponse	(The one Waste Pile Questionnaire and one TSD Questionnaire assigned to this category are included, for statistical purposes, in the CERT nonreponses.)

submitted Part A permit applications to treat, store or dispose of hazardous waste. Accordingly, these installations were sent a questionnaire package containing a Generator Questionnaire, plus the introductory materials and appendices for the survey. Generators sampled from the Part A/Telephone Verification file were known (due to their responses in the Telephone Verification) or expected (because they had filed Part A applications) to be generators of hazardous waste who managed at least some waste on site. They were sent Treatment, Storage and Disposal General Questionnaires, as well as Generator Questionnaires. (Some Part A facilities may also have been sampled to receive one or more process-specific management technology questionnaires, as well as the Generator Questionnaire.)

Followup and processing strategies for the Notifier generators were not identical to those for the Part A/ Verification generators, so the production statistics for the two groups will be discussed separately first, and then as combined Generator Sample. Table B-1 shows the return status for Notifier generators, for generators selected from the Part A/Telephone Verification file, and for all sampled generators.

B.2.2.1 Return Rate for Generators Selected from the Notifier File

A total of 10,667 installations were sampled from the Notifier file to receive Generator Questionnaires. Of these, responses were received from 9,361 installations. Responses for some installations consisted of a determination of ineligibility for the survey, based on telephone calls or other evidence (such as correspondence), rather than a returned questionnaire. Completed (eligible) responses were received from 1,821 installations, which represents 17.1 percent of the sampled

Table B-1. Generator Questionnaire return status

Return Status	Return status for generators selected from the Notified File		Return status for generators selected from the Part A/ Telephone Verification File		Return status for all sampled generators	
	Number	Percent	Number	Percent	Number	Percent
Total responses	(9,361)	(87.8)	(516)	(93.3)	(9,877)	(88.0)
Complete	1,821(1)	17.1	377(3)	68.2	2,198(5)	19.6
Ineligible	7,540(2)	70.7	139(4)	25.1	7,679(6)	64.8
Total Non-responses	(1,306)	(12.2)	(37)	(6.7)	(1,343)	(12.2)
No contact	57	0.5	0	-	57	0.5
Not deliverable	239	2.2	8	1.4	247	2.2
Certified card received	848	7.9	13	2.4	861	7.9
Time extension granted	6	0.1	2	0.4	8	0.1
Refused	11	0.1	8	1.4	19	0.1
Closed	145	1.4	6	1.1	151	1.4
Total Mailed Out:	10,667	100.0	553	100.0	11,220	100.0

(1) Includes 111 unprocessed completed Generator Questionnaire responses received after the field period had ended.
(2) Includes 741 unprocessed ineligible Generator Questionnaire responses received after the field period had ended.
(3) Includes 3 unprocessed completed Generator Questionnaire responses received after the field period had ended.
(4) Includes 2 unprocessed ineligible Generator Questionnaire responses received after the field period had ended.
(5) Includes 114 unprocessed completed Generator Questionnaire responses received after the field period had ended.
(6) Includes 743 unprocessed ineligible Generator Questionnaire responses received after the field period had ended.

10,667 Notifier file installations. The response rate for Notifier installations was 87.8 percent.[1] Table B-1, Column 1, presents the return status for the Notifier generator sample.

Nonrespondents from the Notifier generator sample were followed up twice by mail. The first recontact was a letter mailed out after the initial 45 days of permitted response time had elapsed. The second followup contract was a letter mailed out approximately 90 days after the initial mailing.

The nonresponding Notifier generator cases were reviewed after the end of the coding period, but before the receipt control file had been closed out. Using selective telephone calls and other evidence (such as installation names), a number of nonresponding Notifier generators were judged to be "ineligibles" (i.e., non-generators). This "cleansed" the receipt control file of at least the most obvious "protective filings" (e.g., by gas stations and shoe stores).

By January of 1983 (in the fourth month of the field period) a high response rate for Notifier generators had been obtained. In addition, a higher-than-expected number of eligible (regulated) generators had responded. Therefore, in mid-January, 1983, the coding operation for this type of generator was closed. The receipt control counts for Notifier generators therefore include 111 completed (eligible) Generator Questionnaires and

---

[1] The computational formula used to calculate response rate (R) is $R = E+I/E+I+NR$ where E is the number of eligible responses, I is the number of ineligible responses, and NR is the number of nonrespondents. The definitional formula from which the computational formula is derived is $R = E/(E+NR(E/I+E))$.

741 ineligible Generator Questionnaires which were not coded. The 111 uncoded completed Generator Questionnaires represent 6.1 percent of the 1,821 completed Notifier generators received, while the 741 uncoded ineligible Generator Questionnaires represent 9.8 percent of the 7,540 ineligible generators.

B.2.2.2 Return Rate for Generators Selected From the Part A/Telephone Verification File

A total of 553 facilities were sampled from the Part A/Telephone Verification file to receive Generator Questionnaires. (This portion of the generator sample also received Treatment, Storage and Disposal General Questionnaires, since they had been identified as TSDF's during the telephone verification and/or had submitted Part A permit applications.) Complete (eligible) Generator Questionnaire responses were received from 377 facilities, which represents 68.2 percent of the total sample. Despite the telephone verification effort, ineligible Generator Questionnaire responses were received from 139 facilities or 25.1 percent of the total sample. In all, Generator Questionnaire responses were received from 516 of the 553 sampled facilities, resulting in a response rate for the Part A/Verification generators of 93.3 percent.[2] Table B-1, Column 2, shows the return status for the Part A/ Verification generator sample.

Nonrespondents from the Part A/Verification generator sample were followed up as part of the more extensive followup efforts directed at TSD facilities. First, an individualized

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[1] The computational formula used to calculate response rate (R) is $R = E+I/E+I+NR$ where E is the number of eligible responses, I is the number of ineligible responses, and NR is the number of nonrespondents. The definitional formula from which the computational formula is derived is $R = E/(E+NR(E/I+E))$.

reminder letter was mailed out to nonrespondents after the initial 45 days of permitted response time had elapsed. A second followup contact consisted of a telephone reminder call to the facility. Telephone followup began in early December, approximately 80 days after mailout of the questionnaires. In addition, for cases where no certified mail cards were returned and where the questionnaire package was not returned marked undeliverable by the Post Office, the Post Office was requested to trace the package to verify the delivery status. (All deliveries were verified for this sample.)

The field period (during which completed responses were accepted for coding) for all TSD facilities (including the Part A/Verification generators) was extended from November 15 to December 15 of 1982 and finally to February 1, 1983. The Part A/Verification sample facilities in general, and therefore the Part A/Verification generators, received more followup attention than the Notifier generators, because several component subsamples of the TSD sample were numerically small (even though they were proportionately large within their strata). In addition, TSD facilities requested and were granted time extensions well into January of 1983 and sometimes beyond.

Because the coding operation for TSD facilities remained open until early February, 1983, almost all of the lateresponding Part A/Verification generators questionnaires were coded. Of the 377 complete (eligible) Part A/Verification generators responding, three (or .08 %) were received too late for coding. Of the 139 ineligible Part A/Verification generators, two (or 1.4 %) were received after the coding operation closed. (Late respondents were not factored into population estimates. However, their small numbers would have little impact on the result.)

B.2.2.3 Return Rate for Combined Notifier and Part A/Verification Generator Sample

A total of 11,220 installations and facilities were sampled from the Notifier and Part A/Verification files to respond to the Generator Questionnaire, representing hazardous waste generators nationwide. Responses were received from 9,877 installations and facilities, of which 2,198 were complete (eligible) responses and 7,679 were ineligible responses. The response rate for the combined sample of generators is 88.0 percent.[3] Table B-1, Column 3, presents the return status for the combined Notifier and Part A/Verification sample.

The response rate for Notifier generators was slightly lower (87.8%) than the response rate for Part A/Verification generators (93.3%). The Part A/Verification generators, due to the fact that they were accompanied by TSD Questionnaires, were followed up more vigorously than Notifier generators (by telephone rather than mail only), and the field period was held open longer.

The most apparent difference between the Notifier and Part A/Verification sample response outcomes may be observed in the Eligibility Rate of the responses from the two groups.[4] (See Table B-2.) Among the 9,361 Notifier file respondents, 1,821

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[3] The computational formula used to calculate response rate (R) is $R = E+I/E+I+NR$ where E is the number of eligible responses, I is the number of ineligible responses, and NR is the number of nonrespondents. The definitional formula from which the computational formula is derived is $R = E/(E+NR(E/I+E))$.

[4] The formula used to calculate the Eligibility Rate (ER) is $ER = E/E+I$ where E is the number of eligible responses and I is the number of ineligible responses.

8. CAPACITY OF TREATMENT, STORAGE AND DISPOSAL FACILITIES

The preceding sections have provided an analysis of quantities of hazardous waste managed in 1981. This final quantitative section of the report focuses attention on the capacity of these facilities to treat, store and dispose of additional quantities of hazardous waste. Capacity availability is an important issue in planning for adequate management of future quantities of hazardous waste.

Respondents to the national TSD General Questionnaire were asked what quantities of hazardous waste (a) actually were and (b) could have been treated, stored or disposed of in 1981. The quantities reported in the "could have been" category were intended to represent the facility's annual capacity to treat, store, and dispose of these wastes. As a result, it is possible to calculate both the "percent utilization of capacity" and the "unused annual capacity" as of the beginning of 1982. This section also analyzes the extent to which hazardous waste management capacity is "readily available" in that it is available at facilities that receive over half of their waste from other firms (i.e., commercial facilities).

The concept of "capacity" requires some careful definition. The following points of clarification are provided to qualify the meaning of capacity as the term is used in the analysis that follows:

- The reported capacity was based only on those facilities estimated to have managed RCRA-regulated hazardous waste in 1981. Almost as many more facilities were "out of scope" (ineligible for the survey) because they did not manage hazardous wastes in 1981, even though they were listed in

B.2.2.3 Return Rate for Combined Notifier and Part A/Verification Generator Sample

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The most apparent difference between the Notifier and Part A/Verification sample response outcomes may be observed in the Eligibility Rate of the responses from the two groups.[4] (See Table B-2.) Among the 9,361 Notifier file respondents, 1,821

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[3] The computational formula used to calculate response rate (R) is $R = E+I/E+I+NR$ where E is the number of eligible responses, I is the number of ineligible responses, and NR is the number of nonrespondents. The definitional formula from which the computational formula is derived is $R = E/(E+NR(E/I+E))$.

[4] The formula used to calculate the Eligibility Rate (ER) is $ER = E/E+I$ where E is the number of eligible responses and I is the number of ineligible responses.

Table B.2. Eligibility Rate Among Respondents From the Notifier File and the Part A/Verification File

Eligibility Status	Number	Percent
Generators selected from the Notifier File:		
Total respondents	(9,361)	(100.0)
Completes (eligibles)	1,821	19.5
Ineligibles	7,540	80.5
Generators selected from the Part A/Verification File:		
Total respondents	(516)	(100.0)
Completes (eligibles)	377	73.1
Ineligibles	139	26.9
All generators in the combined sample:		
Total respondents	(9,877)	(100.0)
Completes (eligibles)	2,198	22.3
Ineligibles	7,679	77.7

were eligible, for an eligibility rate of 19.5 percent. In comparison, the table indicates that the eligibility rate for Part A/Verification generators is almost four times greater, at 73.1 percent. (Among 516 Part A/Verification generator respondents, 377 were eligible.) The higher eligibility rate among the Part A/Verification generators is due primarily to telephone verification of the universe list prior to sample selection.

A second factor that could account for this higher observed eligibility rate is the more extensive information requirements contained in EPA's Part A permit application forms. Notification forms simply required location and contact information, an indication of whether hazardous wastes were generated, treated/stored/disposed, transported, or injected at the site, and list of hazardous wastes that would be generated. Part A permit applications, however, required extensive site descriptions, including, but not limited to, maps and diagrams, descriptions of the specific processes used to treat/store/dispose of hazardous wastes at the site, and breakdowns of waste quantities managed by the processes in which they were to be managed. Given the greater work load involved, it seems reasonable to expect that firms would examine their operations more carefully to determine whether hazardous wastes were actually present before submitting their applications. Thus, it is not surprising that a higher percentage of the firms submitting Part A applications would be observed to actually manage or generate hazardous wastes than the firms that were only required to submit notification forms.

B.2.3 Response Rates for Treatment, Storage and Disposal Facilities

Facilities sampled from the Part A/Telephone Verification file were each sent a Treatment, Storage and Disposal General Questionnaire, as well as at least one process-specific management technology questionnaire or a Generator Questionnaire. The titles of the nine questionnaires that could have been included with the TSD Questionnaire are listed in Figure B-4. (See Appendix A for a complete description of sampling strategies.) The maximum number of questionnaires received by any one facility was five. The response rate and return status of the Generator Questionnaire component for TSD facilities that received Generator Questionnaires is discussed in Section B.2.2.3 and in Tables B-1 and B-2. In this section, the response rates for the Treatment, Storage and Disposal General Questionnaire, as well as for the process-specific management technology questionnaires, will be discussed.

Table B-3 presents the return status for the TSD questionnaire and the eight process-specific management technology questionnaires. Table B-4 presents the Eligibility Rates for the TSD and technology questionnaires.

B.2.3.1 Response Rate for the Treatment, Storage and Disposal General Questionnaire

A sample of 2,599 facilities was drawn to receive Treatment, Storage and Disposal General Questionnaires. These facilities were selected from the Part A/Telephone Verification file, and had indicated during the telephone verification survey

Figure B-4 Titles of the Nine Questionnaires that Were Mailed with the Treatment, Storage, and Disposal Questionnaire

1. **Hazardous Waste Container Questionnaire**
2. **Hazardous Waste Generator Questionnaire**
3. **Hazardous Waste Incinerator Questionnaire**
4. **Hazardous Waste Landfill Questionnaire**
5. **Hazardous Waste Land Treatment Questionnaire**
6. **Hazardous Waste Surface Impoundment Questionnaire**
7. **Hazardous Waste Tank Questionnaire**
8. **Hazardous Waste Underground Injection Well Questionnaire**
9. **Hazardous Waste Pile Questionnaire**

Table B-3. Return Status for TSD and Component Questionnaires

Return Status		Injection Wells	Landfills	Land Treatment	Surface Impoundments	Waste Piles	Incinerators	Containers	Tanks	TSD General
TOTAL RESPONSES	N (%)	103 (89.6)	172 (85.1)	99 (81.1)	298 (91.1)	215 (88.5)	239 (90.2)	389 (92.0)	772 (91.1)	2.353 (90.5)
Complete	N (%)	73 (63.5)	79 (39.1)	37 (30.3)	145 (44.3)	73 (30.0)	129(1) (48.7)	195(2) (46.1)	288(4) (34.0)	1,479(3) (56.9)
Ineligible	N (%)	30 (26.1)	93 (46.0)	62 (50.8)	153 (46.8)	142 (58.4)	110 (41.5)	194 (45.9)	484 (57.1)	874 (33.6)
TOTAL NON-RESPONSES	N (%)	12 (10.4)	30 (14.9)	23 (18.9)	29 (8.9)	28 (11.5)	26 (9.8)	34 (8.0)	75 (8.9)	246 (9.5)
No Contact	N (%)	1 (0.9)	0 —	16 (13.1)	1 (0.3)	1 (0.4)	0 —	3 (0.7)	4 (0.5)	23 (0.9)
Not Delivered	N (%)	3 (2.6)	5 (2.5)	1 (0.8)	1 (0.3)	7 (2.9)	6 (2.3)	8 (1.9)	19 (2.2)	49 (1.9)
Cert Card Rec'd	N (%)	5 (4.3)	15 (7.4)	1 (0.8)	10 (3.1)	8 (3.3)	5 (1.9)	7 (1.7)	31 (3.7)	78 (3.0)
Time Extended	N (%)	0 —	3 (1.5)	1 (0.8)	2 (0.6)	1 (0.4)	2 (0.7)	1 (0.2)	0 —	12 (0.5)
Ques NR	N (%)	0 —	1 (0.5)	0 —	2 (0.6)	1 (0.4)	0 —	0 —	1 (0.1)	3 (0.1)
Refused	N (%)	3 (2.6)	1 (0.5)	0 —	4 (1.2)	1 (0.4)	5 (1.9)	12 (2.8)	5 (0.6)	30 (1.2)
Closed	N (%)	0 —	5 (2.5)	4 (3.3)	9 (2.8)	9 (3.7)	8 (3.0)	3 (0.7)	15 (1.8)	51 (2.0)
TOTAL MAILED	N (%)	115 (100.0)	202 (100.0)	122 (100.0)	327 (100.0)	243 (100.0)	265 (100.0)	423 (100.0)	847 (100.0)	2599 (100.0)

(1) Includes 4 unprocessed completed Incinerator Questionnaire responses received after the field period had ended.
(2) Includes 4 unprocessed completed Container Questionnaire responses received after the field period had ended.
(3) Includes 17 unprocessed completed TSD General Questionnaire responses received after the field period had ended.
(4) Includes 5 unprocessed completed Tank Questionnaire responses received after the field period had ended.

Notes

(a) Collapsed categories: The counts of Partial Completes were included in the counts of Completes. (There was one Partial Complete Incinerator Questionnaire response and one Partial Complete TSD General Questionnaire response.) The counts of "Other" types of nonrespondents were included in Certification Card Received counts. (There was one "Other" Waste Pile Questionnaire nonresponse and one "Other" TSD General Questionnaire nonresponse.

(b) Anonymous responses: Approximately ten facilities obliterated or removed all survey identifiers from their response forms, thus making it impossible to log their responses. Only five of these facility responses were useable due to requirements involving weighting. For the purposes of this table, these five responses were added into the counts of Completes, and subtracted out of the counts of Certified Card Received. There were two useable anonymous Landfill Questionnaire responses, three useable anonymous Land Treatment responses, and five useable anonymous TSD General Responses. The unuseable anonymous responses were not included among the Complete responses, and are still included in some category of nonresponse.

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Table B-4. Eligibility Rates for the Treatment, Storage, and Disposal Questionnaire and the Technology Questionnaires

Questionnaire	Total Responses	Total Eligible (Complete) Responses	Eligibility Rate*
TSD General	2,353	1,479	62.9%
Injection Wells	103	73	70.9%
Landfills	172	79	45.9%
Land Treatment	99	37	37.4%
Surface Impoundments	298	145	48.7%
Waste Piles	215	73	34.0%
Incinerators	239	129	54.0%
Containers	389	195	50.1%
Tanks	772	288	37.3%

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* The Eligibility Rate was calculated by dividing the number of eligible responses by the total number of responses.

that they were TSD facilities during 1981.[5] Responses were received from 2,353 facilities for a response rate of 90.5 percent. Of the 2,353 responses, almost two thirds (62.9%, or 1,479 facilities) were eligible responses. The remaining 874 responses were from ineligible (i.e. facilities that did not treat, store or dispose of hazardous wastes in processes regulated under RCRA during 1981) facilities. Of the 246 TSD Questionnaires that were not returned, 49 represented facilities to whom it was not possible to mail the questionnaire package; 51 were for facilities that reported that they were closed after January 1981, but were unable to answer the questionnaires; and 78 facilities had not responded by the end of the survey. Together, these three types of nonresponse make up nearly two thirds of the total nonresponse for the TSD Questionnaire. Thirty facilities (or 1.2% of the total sample) refused to complete the TSD Questionnaire.

B.2.3.2 Response Rate for the Underground Injection Wells Questionnaire

Of the 115 facilities that were mailed Injection Wells Questionnaires, responses were received from 103 for a response rate of 89.6 percent. Over two thirds of the responses (70.9%, or 73 questionnaires) were completed questionnaires from facilities with regulated injection wells. The remaining 30 responses were ineligible (that is, from facilities that did not inject hazardous waste into underground injection wells during 1981).

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[5] The TSD sample actually comprised the nine technology questionnaire samples. The original TSD sample contained 2,557 sampled facilities, but was increased by a supplementary sample of 42 facilities in the Land Treatment sample.

Of the twelve nonresponses, four could not be reached by mail (one was a "no contact", and three were "not delivered"), and five were simple nonresponses. Three facilities (2.6% of the sample) refused to answer the Injection Wells Questionnaire.

B.2.3.3 Response Rate for the Landfill Questionnaire

Of the 202 facilities that were mailed Landfill Questionnaires, responses were received from 172, for a response rate of 85.1 percent. Less than half (about 46%, or 79 responses) were completed questionnaires from facilities that disposed of hazardous waste in landfills during 1981. Of the thirty facilities that did not respond, five were "not delivered" and five were "closed". Nineteen facilities did not respond during the field period, and one facility (0.5% of the sample) refused to respond to the Landfill Questionnaire.

B.2.3.4 Response Rate for the Land Treatment Questionnaire

There were 99 responses to the 122 Land Treatment Questionnaires that were mailed out. The response rate for the Land Treatment sample is, therefore, 81.1 percent. This is the lowest response rate for any of the samples for this survey. There was a comparatively large proportion of "no contact" nonresponses (where certified mail cards were not returned) in the Land Treatment sample (16 facilities or 13.1 percent of the total number of land treatment facilities sampled). A little over one third (37.4%, or 37 questionnaires) of the Land Treatment responses were eligible responses from facilities that disposed of hazardous waste through land treatment processes during 1981. The remaining 62 questionnaires were from facilities that did not dispose of hazardous waste through land treatment processes during 1981. Indications of land treatment on Part A permit applications appear to have been heavily inflated due to applicant misidentification. Land application was often confused with other disposal and treatment technologies (such as landfilling, open burning and surface impounding). The 16 facilities where no contact was documented accounted for most of the nonresponses to the Land Treatment Questionnaire. In addition, one questionnaire package was not deliverable. Two facilities had not responded by the end of the study period, although one had requested a time extension. Four of the sampled facilities were closed, and unable to answer the questionnaires. There were no direct refusals among the sampled land treatment facilities.

B.2.3.5 Response Rate for the Surface Impoundment Questionnaire

Of the 327 facilities that were sent Surface Impoundment Questionnaires, responses were received from 298, for a response rate of 91.1 percent. Approximately half (48.7%, or 145 questionnaires) of the responses were from facilities that used surface impoundments for treatment, storage or disposal of hazardous waste during 1981. The remaining 153 responses to the Surface Impoundment Questionnaire were returned by facilities that did not use surface impoundments for hazardous waste during 1981. There were 29 nonresponding surface impoundment facilities at the end of the survey period. Only two facilities (less than 1% of the sample) could not be contacted. Fourteen facilities had not responded by the end of the survey, representing 4.3 percent of the sample. Nine of the surface impoundment facilities (almost 3%) had closed and were unable to answer the questionnaires. There were four refusals among the surface impoundment facilities.

B.2.3.6 Response Rate for the Waste Piles Questionnaires

Of the 243 facilities that were sent Waste Piles Questionnaires, responses were received from 215, for a response rate of 88.5 percent. About one third of the responses (34%, or 73 questionnaires) were from facilities that stored hazardous waste in waste piles during 1981. The remaining 66 percent of waste pile responses were from facilities that did not store hazardous waste in piles during 1981. This represents the lowest eligibility rate among all eight of the waste management technology questionnaires. Reasons for the low eligibility rate included protective filing, respondent/applicant misidentification of the technology and, possibly, respondent use of the technology for treatment or disposal, rather than for storage. At the time the questionnaire was developed, waste piles were regarded by the EPA as only a storage process. Waste piles are now recognized as a possible disposal process, and are therefore regulated under more stringent standards (e.g., requiring groundwater monitoring). However, the questionnaire deals with waste piles only as a storage process.

Twenty-eight, or 11.5 percent, of the waste piles facilities were nonrespondents. There were eight facilities that could not be contacted by mail (one "no contact" and seven "not delivered"). Ten facilities did not respond during the survey period (including one facility with a time extension and one facility that returned other questionnaires, but did not return the Waste Pile Questionnaire). And nine facilities were closed and unable to respond. There was one refusal, accounting for less than one-half percent of the waste piles sample.

B.2.3.7 Response Rate for the Incinerator Questionnaire

Of the 265 facilities that were sent Incinerator Questionnaires, responses were received from 239, for a response rate of 90.2 percent. A little over half (about 54%, or 129 questionnaires) of the responses were received from facilities that burned hazardous waste in incinerators regulated under RCRA during 1981. The remaining 46 percent of the Incinerator Questionnaires were returned by facilities that did not burn hazardous waste in incinerators regulated under RCRA during 1981. Eight of the 26 nonresponding incinerator facilities were closed, and unable to respond. Six of the incinerator questionnaire mail packages could not be delivered, and seven facilities had received their packages but did not respond during the field period. There were five facilities that refused to respond to the Incinerator Questionnaire, representing 1.9 percent of the incinerator facility sample.

B.2.3.8 Response Rate for the Container Questionnaire

Of the 423 facilities that were sent Container Questionnaires, responses were received from 389, for a response rate of 92.0 percent. This is the best response rate among all of the technology questionnaires, and is also a better response rate than that of the TSD General Questionnaire (with 90.5%). Half of the responses (50.1%, or 195 questionnaires) were received from facilities that did engage in regulated container storage during 1981, while the other half of the responses were from facilities that did not store (for 90 days or longer) hazardous waste in containers during 1981. Respondents' original misidentifications of their facilities as container storage facilities seemed to be due largely to the fact that many respondents were unaware of the exemption from regulation that applies to generators who store their wastes in containers for less than 90 days. There were 34 nonresponding facilities in the container sample. Eleven could not be reached by mail; eight did not respond within the field period. Three facilities could not respond because they were closed. Twelve facilities refused to respond to the Container Questionnaire, representing 2.8 percent of the container sample.

B.2.3.9 Response Rate for the Tank Questionnaire

Both the sample of treatment tank facilities and the sample of storage tank facilities were sent an integrated Tank Questionnaire (with storage and treatment questions combined into a single Tank Questionnaire). Of the 847 facilities that were sent Tank Questionnaires, responses were received from 772, for a response rate of 91.1 percent. However, only slightly more than one third (37.3%, or 288 questionnaires) of these responses were from facilities that had RCRA regulated treatment and/or storage tanks during 1981. Respondents' original misidentifications of their facilities as storage and/or treatment tank facilities seemed to be due largely to the fact that many respondents were unaware of the exemption from regulation that applies to generators who store their wastes in tanks for less than 90 days (see 40 CFR 262.34), and the exclusion from regulation under RCRA of wastewater treatment tanks that are regulated under NPDES (see 40 CFR 264.1(6)). Thus, 484 of the responding facilities did not have RCRA regulated storage or treatment tank facilities on site, although many reported non-regulated tanks.

There were 75 Tank Questionnaire nonrespondents. Of these, 23 facilities could not be contacted, and 32 facilities were contacted (by evidence of the certified mail card) but did not respond. Fifteen facilities were closed, and unable to respond. Five facilities refused to complete the Tank Questionnaire, representing less than 1 percent of the combined storage and treatment tank samples.

B.3 Technical Assistance

Technical assistance was provided to mail survey respondents in two ways: Westat provided a toll free number which was staffed by data collection information specialists and EPA provided assistance through the RCRA Hotline. Technical assistance was provided extensively throughout the field period.

More than 2,600 telephone calls were placed to the Westat 800 number and at least as many return calls were placed from Westat. During the heaviest calling period, September 17 through October 21, as many as five information specialists were required to staff the telephones. (The Westat toll-free information service was in operation between 8:00 a.m. and 5:30 p.m., Eastern time, on weekdays, from September 1982 through January 31, 1983.)

Most of the calls concerned the following issues:

- Whether or not the facility was regulated because it was a small quantity generator;
- Requests for time extensions;
- How to interpret questions in the questionnaires;
- Requests for replacement questionnaires or additional information for corporate offices; and
- Combinations of the above concerns.

Respondents with questions about the instructions in the questionnaire or about definitions or interpretations of questions in the questionnaires, and respondents with procedural problems (e.g., requiring additional copies of material) were assisted directly by the Westat data collection specialists. Respondents with questions requiring interpretation of the regulations were referred by the Westat Hotline staff to the EPA RCRA Hotline. During September and October of 1982, the RCRA Hotline reported handling more than 1,100 calls that were directly related to the hazardous waste survey. It is estimated that survey-related calls increased the total number of calls handled by the EPA RCRA Hotline staff by as much as 20 percent during the heaviest calling period.

Most calls to Westat were placed immediately after the facility received the questionnaire package; the number of calls began to decline about two weeks after the mailout was completed.

B.4 Nonresponse Reduction Efforts

Nonresponse reduction efforts included mail and telephone reminder (followup) contacts, tracing of "lost" mail, and the time extensions granted to those respondents that requested them. The nonresponse reduction strategy for the Notifier file sample (of hazardous waste generators who manage their waste off site) was slightly less rigorous than the strategy applied to the Part A/Verification file sample (of telephone verified TSDs from the Part A file). This was because an adequate (and better than expected) number of responses had been achieved for the Notifier file sample fairly early in the field period, and critical sample sizes in several TSD technology subsamples required more intensive followup effort.

B.4.1 Mail Followup Contacts

As indicated in previous sections, each facility that had not responded at the end of the legally established 45-day period was sent an individualized followup letter. (See Exhibit B-4 for an example followup letter.) The letter advised the facility/installation that its response had not been received, and reminded the facility/installation of its legal obligation to respond.

In addition, installations sampled from the Notifier file that had not responded by early January were sent a second reminder/enforcement letter.

B.4.2 Followup Telephone Calls

Response rates for specific component (technology) subsamples of the Part A/Verification sample were particularly critical because of the relatively small number of facilities engaged in certain activities, and the resultant small sample sizes. Therefore, telephone followup, rather than a second mail followup was employed to obtain the second responses from Part A/Verification sample nonrespondents. The telephone followup is a more effective medium than the mail reminder (although more costly as well), and provided assurance that the reminder reaches the right person at the facility.

Three hundred and thirty of the Part A/Verification sample facilities had not responded by December 13, 1982. Between December 13 and December 17, 1982, followup calls were placed to 314 (or 95%) of these facilities. By the end of the survey period, there was a total of 94 TSD facilities for which no final disposition or response had been obtained. (Eighty-two of

Exhibit B-4. Followup Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

r.e: EPA I.D. No. [ ]

Dear [ ]

A U.S. Environmental Protection Agency Hazardous Waste Questionnaire package regarding the site corresponding to the EPA I.D. Number referenced above was mailed to you at this address under a cover letter dated August 17, 1982, and signed by Dr. John Skinner, Acting Director, Office of Solid Waste.

The questionnaire was sent to you via certified mail (Certified Mail Control Number [ ]) under the authority of Section 3007(a) of the Resource Conservation and Recovery Act. Your response, which is required by law, was due within 45 days of the date the questionnaire package was delivered to this address.

Our records indicate that the questionnaire package was accepted at this address on [September , 1982]. As such, your completed questionnaire should have been returned to EPA post-marked no later than [October , 1982.] As of this date, however, the completed questionnaire corresponding to the EPA I.D. No. referenced above has not been received by EPA.

The purpose of this letter is to remind you of your obligation under law to complete the questionnaire you received for this site and return it to EPA in a timely fashion. Failure to furnish the requested information could subject you to civil penalties or other appropriate legal action under Section 3008 of RCRA. In addition, Federal law provides for both civil and criminal remedies in case of knowing or willful falsification, concealment, or covering up of material facts that are the subject of the questionnaire (18 U.S.C. §1001).

Exhibit B-4 (cont'd)

As noted in Dr. Skinner's August 17, 1982, cover letter, information obtained from this questionnaire will be used to reevaluate the effectiveness of our existing regulatory program and to identify situations where regulations could achieve equal protection at lower cost.

We expect the prompt return of your overdue questionnaire. If you require additional copies of the questionnaire, or if you are experiencing difficulties in completing the instrument, please call our toll-free RIA mail questionnaire assistance service at: (800) 638-3000. Completed questionnaires or other written comunications should be directed to:

Mr. George A. Garland
Analysis Branch Chief
Office of Solid Waste (WH-562)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Let me remind you once again that your response to this questionnaire is required by law. You are advised to return the completed questionnaire to EPA as soon as possible.

Sincerely,

W. Lamar Miller, Director
Waste Programs Enforcement
Office of Solid Waste and Emergency Response
U.S. Environmental Protection Agency

these facilities simply had not responded. Twelve facilities had requested and received time extensions but had not responded by the end of the survey period.)

B.4.3 Time Extensions

Approximately 5,000 facilities/installations asked EPA for, and were granted, extensions on the due date of their questionnaires.

For both the Notifier sample and the Part A/Verification sample, it was necessary to extend the survey period to accommodate responses from facilities/installations that had received time extensions.

B.5 Data Preparation

Data preparation began with a development phase involving questionnaire layout and code manual design. Operational phases included document handling (including receipt control), coding/editing, data entry, and machine editing.

B.5.1 Questionnaire and Code Manual Design

Questionnaire layouts were designed for ease of data preparation/data processing, as well as for ease of respondent understanding and recording. Many items were designed as "precoded" questions, that asked the respondent to answer by circling a code to indicate his/her response. This eliminated the need for a coder to translate check-marks or other non-code symbols into coded answers. Computer field positions were printed in the questionnaires for most data items. These field positions (which were distributed on 130 column records for ease of reading raw listings) were useful as reference locations for coders, machine editors, and data entry staff. Questionnaire layouts were standardized among the ten questionnaires, to the greatest extent possible, to minimize confusion and to minimize documentation, software and training requirements.

Code manuals were developed for each of the 10 questionnaire types. These manuals described the data to be encoded from the questionnaire, item by item. Figure B-5 lists the item characteristics by which each data item was described in the code manuals. Exhibit B-5 is an example data item description from the Treatment, Storage and Disposal General Questionnaire.

Figure B-5. Item Characteristics Described in Code Manuals

a. Field position and record number

b. Item name (the name by which the item was called in all computer programs and other documentation)

c. Quotation of the item from the questionnaire

d. List of all code values and their definitions

e. List of reasons for legitimate item nonresponse (the "inapplicable" definition)

f. List of all missing value codes

g. Flags indicating logical relationships between the item and subsequent items.

Exhibit B-5. Code Manual Data Item Description

Q30 125 Is this facility located within one mile of a fault that has had displacement within the past 10,000 years (Holocene time)? [CIRCLE ONLY ONE CODE]

+ = Inapplicable, coded +'s in Q3B, Q3C and Q3D, col 75-80, record 01
1 = Yes
2 = No
8 = DK
9 = Not ascertained

Code +'s in Q31 - Q36, col 126-127, rec 17, and col 16-33, rec 18 —— 2, 8, 9

B.5.2 Document Handling

Documents were logged in at the time they were received, on an automated (computerized) receipt control system. (See Section B.2 for a detailed description of the receipt control system.) All documents from one facility were handled and filed under one control number. This made it possible to edit across questionnaires, when there were two or more questionnaires per facility.

B.5.3 Coding/Editing

Because there were many more facilities responding with only Generator Questionnaires, than with Treatment, Storage and Disposal General Questionnaires and technology questionnaires, two crews of coders were trained. One crew specialized in coding just the Generator Questionnaire, and the other crew was trained incrementally to handle all ten of the questionnaires. The initial training session, which covered procedural matters as well as the specific coding of the Generator Questionnaire, was attended by both crews of coders. The coders' training included an item-by-item discussion of the coding of the document, practice coding examples, and group review of the coding of practice examples. Training materials included code manuals, practice examples, and a marked up version of the questionnaire that linked the questionnaire to the code manual and the general coding instructions. The initial coder training session consisted of approximately twelve hours of training, spread over two days. Coders assigned to TSD and technology questionnaires were given an additional two to four hours of training per questionnaire.

Coders were trained to edit questionnaire responses for consistency and completeness as they were coding them. Coders flagged any problems they discovered during coding, and referred the problem questionnaires to the coding supervisors. Some problems required the development of new codes -- such as when different units of measure than those specified in the questionnaire were specified for quantity questions. Other problems required that the respondent be called to verify a response or provide missing information (a process called "data retrieval"). In some instances, decisions could be made based on the evidence available, by the Project Officer or by other EPA staff. Decisions, both general and case-specific, were recorded in a Decision Log, for future reference.

All coding was 100 percent sight verified prior to being sent for data entry.

B.5.4 Data Entry

Data was entered ("keypunched") by highly trained data entry operators, using a key-to-tape entry system. This key-to-tape system is computer driven and provides a formated entry keying program that minimizes many types of data entry errors. All data entry was 100 percent key verified by a different operator from the entry operator.

B.5.5 Machine Editing

Machine editing is a means of data quality control that uses a computer program to test item ranges, skip patterns, and logical consistencies in a data file. Such a machine edit program was prepared for each of the ten questionnaires. The data file for the Notifier generators was a simple one-questionnaire-per-installation file, so its edit program consisted of a single program. For the Part A/Telephone Verification TSD facility file, however, the complete record for a TSD facility consisted of a TSD questionnaire plus at least one (and up to four) technology questionnaires. The machine edit program for this file used the TSD Questionnaire as a base and provided for the co-editing of each additional technology questionnaire. (That is, the ten programs were linked together to make up one edit program.) This made it possible to do at least some computerized interquestionnaire checking.

Machine editors were selected from the trained stock of coders available from the two questionnaire coding crews. The training consisted of procedural instructions, and a walkthrough using an example edit problem.

The machine edit programs provided a list of test errors for each edited case, as well as a listing of each case in error. Each of the errors was checked, and often the hard copy of the case was reviewed. Updates to the data files were written on update sheets, key entered and run against the data file to produce a new master file. Then the edit cycle was rerun to make sure that the update corrections had been made correctly. Because of the complexity of some of the technology data files, it was necessary to rerun edit cycles several times: updates to some fields tended to unexpectedly impact consistencies with other fields.

After the final machine edit cycles, frequency distributions for all items of the data files were reviewed by supervisors to spot problems not captured by the machine edit programs.

B.6 Data Retrieval

Data retrieval is the term used to refer recontacting respondents for the purpose of verifying or clarifying responses to completed questionnaires or interviews. For this study, recontact of respondents generally took the form of a telephone call, though occasionally it was necessary to mail a list of questions to a respondent.

The need for a questionnaire to have data retrieval could have been determined at several stages during the data preparation process (and indeed, some data retrieval work was done during the analysis stage.) Initially, a list of key "must-be-answered" questions was provided by EPA staff. Missing key items (or inconsistent key items) were often flagged by coders during the coding/editing process. In addition, some questionnaires required data retrieval in order to determine the hazardous waste management or generation status of the facility.

Data retrieval staff consisted initially of Westat's Hotline personnel. As the need for a larger data retrieval staff grew, the hotline staff trained others to assist in the retrieval calls. The data retrieval staff ultimately included Westat Hotline personnel, the receipt control supervisor, coding supervisors, coders, telephone interviewers, and EPA staff.

During the data preparation period, a total of 1,005 installations from the Notifier generartor file (or 11% of the 9,361 respondents) received data retrieval calls. And a total of 762 (or 32%) of the 2,353 Part A/Telephone Verification file respondents received data retrieval calls. In additon to these calls, analysts from EPA and from Westat have made additional data retrieval calls during the analysis period.

B.7 Confidentiality

Respondents were informed, in the cover letter to the questionnaire package, that they could assert a claim of business confidentiality as provided in Title 40 of the Code of Federal Regulations, Part 2, Subpart B, and according to the procedures set forth in Section 40 CFR 2.203 (b). A total of 93 Part A/Telephone Verification facilities and 36 Notifier generator installations (or a total of 129 sites, overall) chose to request business confidentiality.

The EPA Office of Solid Waste received all incoming survey mail and screened all responses for requests for CBI prior to forwarding survey responses to Westat for coding. All incoming responses with CBI claims were held by the Project Officer at the EPA Office of Solid Waste in a locked file. At the end of the survey, after deleting all identifying information and assigning pseudo-identifiers to the CBI responses, the questionnaires were coded and entered on the data file. The EPA Project Officer holds the link list of actual and pseudo-identifiers in a locked file at the EPA Office of Solid Waste.

In addition, Westat entered into agreements with two corporations concerning confidentiality. And one trade association acted as a go-between, funnelling anonymous responses from its members. (It was not possible to use many of the responses from this organization, since many of the questionnaires could not be assigned correct sample weights.)

All Westat staff involved in this project signed standard Westat confidentiality agreements. In addition, all staff members were required to sign EPA confidentiality agreements.

APPENDIX C

SELECTED REGULATIONS IMPLEMENTED UNDER THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976, AS AMENDED

federal register

Monday
November 17, 1980

Part X

Environmental Protection Agency

Hazardous Waste Management System: Suspension of Rules and Proposal of Special Standards for Wastewater Treatment Tanks and Neutralization Tanks

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 122, 260, 264 and 265

[WH-FRL 1670-3]

Hazardous Waste Management System; General and Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities and EPA Administered Permit Programs: The Hazardous Waste Permit Program

AGENCY: Environmental Protection Agency.

ACTION: Final amendments to rule.

SUMMARY: EPA is today promulgating amendments that suspend the applicability of the requirements of the hazardous waste regulations in 40 CFR Parts 122, 264 and 265 to owners and operators of (1) wastewater treatment tanks that receive, store, and treat wastewaters that are hazardous waste or that generate, store or treat a wastewater treatment sludge which is a hazardous waste where such wastewaters are subject to regulation under Sections 402 or 307(b) of the Clean Water Act (33 U.S.C. 1251 *et seq.*) and (2) neutralization tanks, transport vehicles, vessels, or containers which neutralize wastes which are hazardous only because they exhibit the corrosivity characteristic under 40 CFR § 261.22 or are listed as hazardous wastes in Subpart D of 40 CFR Part 261 only for this reason. Concurrently, under separate action, EPA is proposing amendments to Parts 122, 260, 264, 265 and 266, to establish special standards and permits requirements for these owners and operators. The Agency intends to continue the suspension created by this action until special standards and permit requirements for these owners and operators are promulgated in final form.

This suspension is being enacted in order to relieve owners and operators of wastewater treatment and elementary neutralization units from having to comply with requirements which the proposed amendments are designed to modify.

EFFECTIVE DATE: November 19, 1980.

FOR FURTHER INFORMATION CONTACT: Alfred W. Lindsey, Office of Solid Waste, [WH-565], U.S. Environmental Protection Agency, 401 M Street, SW., Washington, D.C. 20460, (202) 755-9185.

SUPPLEMENTARY INFORMATION:

I. Reason and Basis for Suspension

On May 19, 1980, EPA promulgated Hazardous Waste Management and Consolidated Permit Regulations (45 FR 33066) under the Resource Conservation and Recovery Act. These regulations, among other things, require owners and operators of facilities who treat or store hazardous wastes to apply for and obtain an RCRA permit (see § 122.22) and require existing facilities which have qualified for interim status (see § 122.23), to comply with the interim status standards of Part 265. Under these regulations, owners and operators of wastewater treatment facilities that are subject to regulation under the Clean Water Act are required to comply with these RCRA treatment and storage requirements where they treat an influent wastewater that is a hazardous waste or generate and store or treat a wastewater treatment sludge which is a hazardous waste. In addition, owners and operators of facilities that neutralize waste that is hazardous solely by virtue of its corrosivity are subject to these treatment and storage requirements.

Many persons have questioned the necessity of regulating these wastewater treatment and neutralization facilities under RCRA. In response to these comments, EPA is today proposing, in a separate action, special standards and permit requirements for wastewater treatment and elementary neutralization units. As is more fully detailed in the preamble to this proposal, the proposed amendments will award owners and operators of these wastewater treatment and neutralization units a permit-by-rule if they comply with certain specified special standards, unless the Regional Administrator terminates eligibility for a permit-by-rule. Accordingly, under this proposal, owners and operators of these wastewater treatment and neutralization units will not have to apply for and obtain individual RCRA permits under Part 122 for these units or comply with the interim status standards of Part 265 applicable to these units.

Unfortunately, the amendments being proposed today cannot be finalized and take effect before November 19, 1980, the date on which the interim status standards and permit requirements of the current regulations take effect. Therefore, unless they are granted a temporary exclusion from regulation, owners and operators of the wastewater treatment and elementary neutralization units covered by the proposed amendments will have to comply, beginning on November 19, 1980, with requirements that the proposed amendments are designed to modify. Among other things, they will have to develop and submit Part A of the RCRA permit applications and comply with the interim status standards if they have achieved interim status. In addition, owners and operators of new facilities will have to develop and submit Part A and B, of the RCRA permit application and obtain a RCRA permit before constructing such facilities. The Agency believes that little practical value, and certain unnecessary disruption, will be achieved by causing owners and operators of these facilities to comply with the current requirements, pending final action on the proposed amendments. Indeed, requiring compliance with the current requirements could, to some extent, frustrate the purpose of awarding these owners and operators a permit-by-rule. Consequently, the Agency is today suspending the current regulations insofar as they apply to the wastewater treatment and elementary neutralization facilities covered by today's proposed amendments. The Agency does not believe this suspension will significantly reduce protection of human health and the environment. The duration of the suspension is expected to be short and most of the wastewater treatment and elementary neutralization units affected by the action currently are believed to be complying with the special standard proposed for these units.

II. Amendments

To achieve the above described suspension of current regulations the Agency is today promulgating the following final amendments:

(1) Section 122.21(d)(2) is being amended to add owners and operators of wastewater treatment and elementary neutralization units to the list of persons not required to obtain a RCRA permit.

(2) Sections 264.1(g) and 265.1(c) are being amended to add owners or operators of these units to the list of owners or operators to which the requirements of Parts 264 and 265 do not apply.

(3) The definitions of §§ 260.10 and 122.3 are being amended by adding definitions for "wastewater treatment unit" and "elementary neutralization unit." These are the same definitions used in the associated amendments being proposed today.

These amendments are being promulgated with an effective date of November 19, 1980. Section 3010(b) of RCRA provides that EPA's hazardous waste regulations and revisions thereto take effect six months after their promulgation. The purpose of this statutory requirement is to allow persons affected by the regulations sufficient lead time to prepare to comply with major new regulatory requirements. For the amendments being promulgated

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in this action, the Agency believes that an effective date six months after promulgation would defeat the purposes of these amendments. Consequently, the Agency is making these amendments effective on November 19, 1980.

Dated: November 10, 1980.

Douglas M. Costle,

Administrator.

Title 40 of the Code of Federal Regulations is amended as follows:

PART 260—HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

1. Add the following definitions to § 260.10(a).

§ 260.10 Definitions.

(a) * * *

(13a) "Elementary neutralization unit" means a device which:

(i) Is used for neutralizing wastes which are hazardous wastes only because they exhibit the corrosivity characteristic defined in § 261.22 of this Chapter, or are listed in Subpart D of Part 261 of this Chapter only for this reason; and

(ii) Meets the definition of tank, container, transport vehicle, or vessel in § 260.10 of this Chapter.

* * * * *

(76a) "Wastewater treatment unit" means a device which:

(i) Is part of a wastewater treatment facility which is subject to regulation under either Section 402 or Section 307(b) of the Clean Water Act; and

(ii) Receives and treats or stores an influent wastewater which is a hazardous waste as defined in § 261.3 of this chapter, or generates and accumulates a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter, or treats or stores a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter; and

(iii) Meets the definition of tank in § 260.10 of this chapter.

* * * * *

PART 264—STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

2. Add the following paragraph to § 264.1(g):

§ 264.1 Purpose, scope and applicability.

* * * * *

(g) * * *

(6) The owner or operator of an elementary neutralization unit or a wastewater treatment unit as defined in § 260.10 of this chapter.

PART 265—INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

3. Add the following paragraph to § 265.1(c):

§ 265.1 Purpose, scope and applicability.

* * * * *

(c) * * *

(10) The owner or operator of an elementary neutralization unit or a wastewater treatment unit as defined in § 260.10 of this chapter.

PART 122—EPA ADMINISTERED PERMIT PROGRAMS: THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM; THE HAZARDOUS WASTE PERMIT PROGRAM; AND THE UNDERGROUND CONTROL PROGRAM

4. Add the following definitions to § 122.3.

§ 122.3 Definitions.

* * * * *

"Elementary neutralization unit" means a device which:

(a) Is used for neutralizing wastes which are hazardous wastes only because they exhibit the corrosivity characteristic defined in § 261.22 of this chapter, or are listed in Subpart D of Part 261 of this Chapter only for this reason; and

(b) Meets the definition of tank, container, transport vehicle, or vessel in § 260.10 of this Chapter.

"Waste water treatment unit" means a device which:

(a) Is part of a wastewater treatment facility which is subject to regulation under either Section 402 or Section 307(b) of the Clean Water Act; and

(b) Receives and treats or stores an influent wastewater which is a hazardous waste as defined in § 261.3 of this chapter, or generates and accumulates a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter, or treats or stores a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter; and

(c) Meets the definition of tank in § 260.10 of this chapter.

* * * * *

5. Add the following paragraph to § 122.21(d)(2):

§ 122.21 Purpose and scope of Subpart B.

* * * * *

(d) * * *

(2) * * *

(vi) Owners and operators of elementary neutralization units or wastewater treatment units as defined in 40 CFR 260.10.

(Secs. 1006, 2002(a), 3004, 3005, Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6905, 6912(a), 6924 and 6925))

[FR Doc. 80-[illegible] Filed 11-14-80; 8:45 am]

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federal register

Tuesday
November 17, 1981

Part VI

Environmental Protection Agency

Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 265

[SWH-FRL 1960-6]

Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

AGENCY: Environmental Protection Agency.

ACTION: Interim final rule and interim final amendments to rules and request for comments.

SUMMARY: The Environmental Protection Agency (EPA) has issued standards applicable to owners and operators of hazardous waste management facilities as required by the Resource Conservation and Recovery Act (RCRA). One of these standards bans the disposal of most containerized liquid hazardous waste in landfills, effective November 19, 1981. As a result of reconsideration of this restriction, EPA is today promulgating an interim final rule to allow the disposal of small containers of liquid and solid hazardous waste in landfills provided that the wastes are placed in overpacked drums (lab packs) in the manner specified in today's rule. The purpose of today's rule is to provide an environmentally sound disposal option for generators of small containers of hazardous wastes, such as laboratories.

DATES: Interim final rule and interim final amendments effective November 17, 1981.

COMMENT DATE: The Agency will accept comments on this rule and amendments until January 18, 1982.

ADDRESSES: Comments should be addressed to Deneen M. Shrader, Docket Clerk, Office of Solid Waste, (WH-562), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460, telephone (202) 755-9173. Comments on today's interim final rule and amendments should identify the regulatory docket as follows: "Section 3004—Lab packs."

FOR FURTHER INFORMATION CONTACT: The RCRA hazardous waste hotline, toll free at (800) 424-9346 (554-1404 in Washington, D.C.). For technical information contact Kenneth Shuster, Program Manager, Land Disposal Branch, Office of Solid Waste (WH-564), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460, telephone (202) 755-9125.

SUPPLEMENTARY INFORMATION:

I. Introduction

On May 19, 1980, EPA promulgated hazardous waste regulations in 40 CFR Parts 260-265 (45 FR 33066 *et seq.*) which established, in conjunction with earlier regulations promulgated on February 26, 1980 (45 FR 12721 *et seq.*), the principal elements of the hazardous waste management program under Subtitle C of the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901, *et seq.*). Since that time, the Agency has received numerous requests to promulgate regulations tailored to the special problems involved in the management of smaller quantities of different hazardous wastes. In particular, some commenters have stated that some of the interim status hazardous waste standards for landfills are geared towards large, homogeneous waste streams but are inappropriate for generators, such as laboratories, who produce smaller quantities of many different wastes. For reasons discussed in Sections II and III of this preamble, many of these commenters have requested that the Agency allow these smaller quantities of waste to be disposed of in landfills when packaged in "lab packs."

Laboratory wastes are commonly collected in small containers ranging in size from an ampule to 5 gallon pails. These containers are surrounded by some type of absorbent material such as vermiculite and overpacked in large drums (usually 55 gallon) prior to disposal in a secure landfill. The entire package is commonly called a lab pack.

Although the term lab pack is generally used to refer to a method of disposing of laboratory wastes, today's rule is not limited to the disposal of such wastes. The disposal option authorized by today's rule may be utilized by any type of generator. It is designed to accommodate generators who produce smaller quantities of many different wastes.

Today's amendments are designed to relax two separate prohibitions against the landfilling of lab packs which would otherwise have become effective on November 19, 1981. Section 265.312 allows the burial of containerized liquid ignitable waste in landfills until November 19, 1981. After that date, liquid ignitable waste may not be placed in landfills. Section 265.314 prohibits, after November 19, 1981, the burial of containerized liquid hazardous wastes except very small containers, such as an ampule, or containers designed to hold liquids for a use other than storage, such as a battery or capacitor. (See 45 FR 33213 (May 19, 1980) and 45 FR 33502 (June 22, 1981) for explanations of thes prohibitions.) The Agency has receive numerous requests to allow lab packs containing liquid and liquid ignitable hazardous wastes to be disposed of in secure landfills after November 19, 198 the effective date of the prohibitions.

The disposal of hazardous wastes in lab packs is a common practice for many small volume generators (not necessarily small quantity generators a defined in 40 CFR 261.5) including, particularly, commercial research laboratories, school laboratories, and large Governmental laboratories. This represents a general trend away from previous improper disposal methods for these types of wastes, such as mixing these wastes in dumpsters with municipal waste or pouring the wastes down the drain.

Preliminarily, it should be noted that many high school, college and university, or other small laboratories may be small quantity generators and, therefore, need not comply with the full RCRA hazardous waste management regulations provided that the wastes a managed in accordance with § 261.5(g) If generators are small quantity generators as defined in 40 CFR 261.5, their wastes, including those placed in lab packs, are not subject to the RCRA regulations contained in Parts 262 through 267 and Parts 122 through 124, or to the notification requirements of section 3010 of RCRA, provided that th generator complies with § 261.5(g). Hazardous wastes subject to the reduced requirements of § 261.5 may be mixed with non-hazardous wastes and remain subject to these reduced requirements, even though the resultan mixture exceeds the quantity limitations identified in § 261.5, unless the mixture meets any of the characteristics of hazardous waste identified in Subpart of Part 261.

Several commenters representing laboratories have stated that although they qualify for the small quantity generator exemption, they would prefe to dispose of their hazardous wastes at a RCRA-permitted or interim status hazardous waste landfill. By allowing the disposal of lab packs in hazardous waste landfills, the Agency is providing a practical disposal option for these generators, as well as for the generato who do not qualify for the small quantity generator exemption.

II. Summary of Comments

Most of the comments that the Agen has received on the subject of lab pack have been in responses to the February 20, 1981 amendment to 40 CFR 265.312, which concerns the disposal of ignitable wastes in landfills. These commenters

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stated that disposal of lab packs in secure landfills is environmentally sound, provided that certain packaging and pretreatment conditions are followed. The commenters, in general, requested that small containers—ampule to 5-gallon pails—should be allowed to be disposed of in lab packs in landfills. One commenter specifically requested that small containers (one gallon and smaller, approved for DOT shipment) be permanently allowed to be landfilled since these non-leaking, small containers, in cartons and palletized, do not pose a substantial risk to human health and the environment. However, the commenter further stated the EPA could require that small containers be placed in 55-gallon steel drums with the voids packed with absorbent materials before landfilling.

The commenters stated that the techniques for handling lab packs prevent the potential for escape of liquids. Additionally, they stated that the quantity of such waste is small and will not burden landfills that are capable of handling chemical waste. Even if the bottles or cans break or leak, the packing will absorb the liquids. Commenters also stated that isolating materials that may be incompatible is very important (i.e., incompatible materials should not be placed in the same lab pack), since chemicals must not be allowed to react to cause fires or other hazards. Further, one commenter provided a list of substances that he felt should not be allowed to be lab-packed for disposal in landfills because, even in small quantities, these substances present too great a hazard for land disposal.

III. Discussion of the Problem

Many thousands of generators currently generate a variety of hazardous wastes in smaller quantities. Most of these generators are laboratories, including chemistry and biology laboratories in junior and senior high schools, colleges and universities, hospitals and clinics, Governmental agencies with laboratories, large and small research firms, and chemical, pharmaceutical and other manufacturing firms.

Although the number of generators fitting this description is not known, the 15th edition of *Industrial Research Laboratories of the United States* contains information on 10,028 research and development facilities belonging to 6,947 organizations engaged in fundamental and applied research, including development of products and processes. Most of the facilities are owned and operated by industrial firms but some foundations and cooperatively supported units are also covered, as well as university laboratories having research facilities separate from university control. The American Chemical Society's *Directory of College Chemistry Faculties* (which covers two- and four-year colleges and universities) lists approximately 2,200 college departments of chemistry, biochemistry, chemical engineering, or medical-pharmaceutical chemistry, each of which can be expected to have at least one laboratory.

The Agency has received several examples indicating the magnitude of laboratory waste generation. One large university stated that it has more than 2,000 laboratories, each or which generates a wide variety of waste chemicals in small quantities. One company that picks up small quantities of laboratory wastes from generators and then packs and transports the wastes in lab packs for disposal commented that it handled over 25,000 different chemicals in approximately 500,000 small containers in 1980. The containers varied generally from ampules of a few grams to 5-gallon pails. One research laboratory stated that it typically generates well over a thousand such small containers (several milliliters up to about one gallon in size) for disposal each month.

The availability of commercial treatment options for small quantities of hazardous waste is greatly limited. A typical laboratory produces small quantities of many different wastes. The variety and quantity of compounds discarded are often unpredictable. Often the specific waste characteristics are unknown and the cost to characterize such wastes is prohibitive. Commercial treatment facilities (e.g., incinerators and solvent recovery operations) typically accept only reasonably sized lots of well-characterized liquid wastes delivered in a form which makes them readily suitable for treatment. Diverse laboratory wastes in small containers are not considered to be readily suitable for treatment by operators of these facilities.

Because in many cases the contents of each small container of laboratory or hazardous waste cannot be precisely defined, commercial waste handlers are reluctant to incinerate them. Proper incineration requires analysis of waste feeds for identification and designation of principal organic hazardous constituents, a very difficult task with respect to diverse drummed wastes.

IV. Solutions

Based on the lack of available treatment or disposal options for laboratory wastes and on the Agency's conclusion that landfill disposal of small containers of hazardous wastes in overpacked drums is environmentally sound, the Agency has decided to allow lab packs to be disposed of in hazardous waste landfills.

The Agency believes that the disposal of lab packs in landfills is an environmentally sound practice. Although the drums in which the laboratory wastes are overpacked will eventually degrade, the Agency believes that by having, at a minimum, sufficient absorbent material in each drum to completely absorb all of the liquid content of the inside containers, lab packs will not contribute substantial volumes of liquids to landfill leachate. Today's requirement that the outside container be full (i.e., absorbent material to the top of the drum with no void space), will assure that no breakage or rupture of the inside containers will occur during handling and placement.

One disposal alternative, other than disposal in lab packs, is to mix liquid wastes with an absorbent material before placement in a drum, or to pour liquid wastes directly into drums with sufficient absorbent material to solidify the liquid wastes. Provided that the liquids are sufficiently absorbed or solidified to remove free liquids, full drums of such treated wastes are already allowed to be landfilled under the regulations, even after the § 265.314 ban on containerized liquids in landfills takes effect. This method differs from packaging in lab packs in that liquid wastes are absorbed prior to disposal rather than contained in inside containers. The effectiveness of the absorption is therefore observable. While the option of mixing before disposal may be viable for some generators, based on the chemical handling procedures of many laboratories, disposal in overpacked inside containers may be much more practical and often safer for small quantities of wastes.

V. DOT and EPA Coordination

The Department of Transportation (DOT) has issued regulations governing the transport of hazardous materials at 49 CFR Parts 171–179. These regulations specify packaging requirements applicable to the transport of hazardous materials in commerce within the United States. However, the DOT regulations do not cover all hazardous wastes and are not applicable to all lab packs (e.g., lab packs disposed of on-site).

It should be noted that EPA has previously adopted certain DOT regulations in its Standards Applicable to Generators of Hazardous Waste (40

CFR Part 262). Pursuant to § 262.30, a generator who transports hazardous waste or offers hazardous waste for transport off-site, must package the waste in accordance with applicable DOT regulations on packaging under 49 CFR Parts 173, 178, and 179. Therefore, any generator transporting lab packs for off-site disposal is already required to conform with all applicable DOT requirements for packaging.

The objective of the DOT regulations is to insure the safe transport of hazardous materials. EPA's concern in promulgating today's regulation is to insure the safe disposal of hazardous wastes. To the extent possible, EPA has adopted DOT specifications for the packaging of lab packs for disposal. However, because the objective of the DOT regulations varies somewhat from the purpose of today's rule, in some cases the requirements of § 265.316 are different, or stricter than the DOT requirements. However, the Agency has attempted to ensure consistency with the requirements of DOT and to avoid the imposition of conflicting requirements wherever possible.

Today's rule applies certain DOT specifications to some situations which are outside of DOT's jurisdiction and thus are not directly covered by the DOT regulations (e.g., lab packs being disposed of on-site). On the other hand, generators or transporters who are already covered by the DOT regulations must still comply with all applicable sections of those regulations. Thus lab packs offered for transportation may, as in the past, be subject to additional DOT requirements such as weight and container size limitations. In addition, DOT prohibits the shipment of corrosive liquids in metal outside drums or barrels (see 49 CFR 173.23) unless an exemption is obtained in accordance with 49 CFR Part 107 Subpart B. Since EPA is requiring metal outside containers for purposes of disposal (§ 265.316(b)), persons subject to the DOT regulations wishing to dispose of corrosive liquids in lab packs must first obtain an exemption from DOT.

VI. Content of the Regulation

To achieve the objectives discussed above, today's regulation adds a new section to Part 265 (§ 265.316) and makes conforming amendments to §§ 265.312 and 265.314. In accordance with today's regulation, wastes to be disposed of in lab packs must be packaged in sealed inside containers. The inside containers must be of a design and constructed of a material that will not react dangerously with, be decomposed by, or be ignited by, the waste held therein. In addition, the inside containers must be of the size and type specified in the DOT hazardous materials regulations (49 CFR Parts 173, 178 and 179), if those regulations specify a particular inside container for that waste. The requirement of using DOT-specified inside containers for purposes of packaging wastes for disposal in lab packs is applicable whether or not the lab pack will be regulated by DOT for purposes of transportation. The reason that EPA is adopting DOT's specifications for inside containers is that EPA seeks to achieve the same objective that DOT has defined in its regulations, namely that the inside containers safely and effectively hold a material without leakage. Based on the fact that EPA seeks to achieve the same objective, the Agency has decided to employ the DOT specifications for inside containers.

The DOT hazardous materials regulations do not specify inside containers for all hazardous wastes, however. Therefore, for any waste not addressed in the DOT regulations, inside containers must meet only the general performance standard (i.e., be of a design and constructed of a material that will not react dangerously with, be decomposed by, or be ignited by, the waste held therein).

In addition to the requirement that the inside containers be non-leaking, the Agency has also included a requirement in § 265.316(a) that all inside containers be tightly and securely sealed. This requirement is intended to help insure that no waste leaks from the inside containers before the lab pack is placed in the landfill.

Section 265.316(d) prohibits the placement of incompatible wastes in the same outside container. The purpose of this restriction is to prevent any potentially dangerous reaction between wastes packaged in the same lab pack. The DOT hazardous materials regulations contain a similar provision. Those regulations state that the offering of packages of hazardous materials in the same packaging, freight container, or overpack, with other hazardous materials, the mixture of contents of which would be liable to cause a dangerous evolution of heat or gas or produce corrosive materials, is forbidden except as specified (see 49 CFR 173.21). EPA has included a similar provision, however, because not all hazardous wastes and thus not all lab packs will be covered by the DOT regulations.

In addition to the prohibition against co-packaging incompatible wastes contained in § 265.316, it should be noted that § 265.313 already prohibits the placement of incompatible wastes or incompatible wastes and materials in the same landfill cell unless § 265.17(b) is complied with. Section 265.17(b) states that: the mixture or commingling of incompatible wastes or incompatible wastes and materials must be conducted so that it does not: (1) Generate extreme heat or pressure, fire or explosion, or violent reaction; (2) Produce uncontrolled toxic mists, fumes, dusts, or gases in sufficient quantities to threaten human health; (3) Produce uncontrolled flammable fumes or gases in sufficient quantities to pose a risk of fire or explosions; (4) Damage the structural integrity of the device or facility containing the waste; or (5) Through other like means threaten human health or the environment. Section 265.313 is, of course, applicable to the placement of lab packs in landfills.

Section 265.316(b) deals with the outside container and the type of absorbent material required. EPA is requiring that the inside containers be overpacked in DOT specification open-head metal drums no larger than 110 gallons in capacity and surrounded by, at a minimum, a sufficient quantity of absorbent material to completely absorb all of the liquid contents of the inside containers. DOT specifications for containers are contained in 49 CFR Parts 178 and 179.

All lab packs must be in DOT specification outside drums, whether or not the wastes contained in the lab pack are covered by the DOT regulations. The reason for this is that these drums have already been determined by DOT to be sturdy enough to safely hold hazardous materials. The 110-gallon capacity limitation coincides with the maximum size DOT specification container. In addition, this capacity limitation is designed to ensure that lab packs will be used for their intended purpose, i.e., the disposal of smaller quantities of many different wastes.

Commenters have stated that many off-site landfill operators will accept containerized wastes only in 55-gallon drums. Comments are specifically solicited on whether a capacity limitation for outside containers is appropriate and if so, what this limitation should be. Based on the volume and content of comments received on this issue, the Agency will consider amending the 110-gallon limitation.

In many cases, the DOT regulations allow a variety of acceptable packaging options including metal, fiberboard, plastic or wooden containers. However, for purposes of disposal, EPA is requiring that all outside containers be metal. The need for metal drums is due to the nature of disposal. Allowing fiber or wooden containers to be used as an outside container would increase the risk of breaking or rupturing the inside containers because fiber or wooden containers are more likely to be ruptured or crushed during handling and after placement in a landfill than are metal drums. The drums must be of the open head variety to allow the proper placement of the inside containers and absorbent.

The inside containers must be overpacked and surrounded, at a minimum, by a sufficient quantity of absorbent material to completely absorb all the liquid contents of the inside containers. In addition, the outside container must be full after packing with the inside containers and absorbent material to prevent breakage of inside containers. The absorbent material used must not be capable of reacting dangerously with, being decomposed by, or being ignited by the contents of the inside containers in accordance with § 265.17(b). The Agency has not specified the type of absorbent that must be used in a lab pack. However, based on comments received, it appears that vermiculite and fuller's earth are commonly used because of their price, availability, and the fact that they will not react dangerously with most wastes.

The Agency has not specified a maximum limit on the size of the inside containers except where the DOT regulations impose a specific requirement. However, the total amount of liquid which may be placed in the lab pack will be limited by the amount of absorbent material required. Of course, the higher the absorptive capacity of the absorbent material used for overpacking, the more liquid the lab pack may contain.

VII. Ban on Certain Reactive Wastes

Section 265.312 bans the disposal of reactive waste in landfills unless the waste is treated or rendered non-reactive prior to or immediately after placement in the landfill. However, as a result of comments received, the Agency recognizes that cyanide- or sulfide-bearing wastes, which are deemed reactive because they meet the characteristic of reactivity set forth in 40 CFR 261.23(a)(5), may be safely landfilled in lab packs provided they are properly handled so as to avoid contact with incompatible wastes, as required by § 265.316(d).

By definition cyanide- and sulfide-bearing wastes are those which will generate toxic gases, vapors, or fumes when exposed to acidic or basic conditions characterized by a pH between 2 and 12.5. All other reactive wastes will explode or release toxic gases, vapors, or fumes, when they are at standard pressure and temperature; when they are mixed with or exposed to water; when they are subject to a strong initiating force; or when they are heated under confinement, or else are DOT-forbidden, Class A, or Class B explosives. While it is possible to isolate cyanide- and sulfide-bearing wastes in a lab pack from wastes or conditions that would cause them to generate toxic gases, vapors, or fumes, it is much more difficult to protect other reactive wastes from conditions which would cause them to explode or otherwise dangerously react, even when packaged in a lab pack. Therefore, today's regulation contains a ban on the landfill disposal of reactive wastes, other than cyanide- and sulfide-bearing wastes, in lab packs unless the waste is rendered non-reactive prior to packaging.

It should be noted that some wastes, such as oxidizers, may meet a characteristic of reactivity as well as the characteristic of ignitability. Although, pursuant to today's rule, ignitable wastes may be landfilled in lab packs, any ignitable waste that also meets a characteristic of reactivity other than § 261.23(a)(5), may not be disposed of in a lab pack unless it is treated or rendered non-reactive prior to packaging.

VIII. Effective Date

Section 3010(b) of RCRA provides that EPA's hazardous waste regulations and revisions to the regulations take effect six months after promulgation. The purpose of this requirement is to allow persons handling hazardous wastes sufficient lead time to prepare and to comply with major new regulatory requirements. Today's amendments are designed to reduce burdens imposed by existing regulations. Therefore, an effective date of six months after promulgation would be contrary to the purpose of section 3010(b). For this reason, this rule and amendments take effect immediately.

IX. Interim Final Rule and Amendments and Request for Comment

EPA is promulgating today's rule and amendments as interim final and is providing a 60-day comment period. The Agency believes that the public should have an opportunity to comment on the rule and amendments and, indeed, has specifically requested comments. However, the Agency believes that the rule and amendments should be put into effect during the comment period. To do otherwise would be contrary to the public interest by causing the regulated community to comply with requirements which this rule and amendments are designed to change. Therefore, the Agency finds that there is a "good cause" to allow today's rule and amendment to take effect prior to notice and public participation under Section 553(b) of the Administrative Procedures Act.

X. Regulatory Impact

Under Executive Order 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirement of a Regulatory Impact Analysis. This interim final regulation is not major since its effect is to reduce the overall costs and economic impact of EPA's hazardous waste management regulations. This reduction is achieved by allowing the landfill disposal in lab packs of certain hazardous wastes which would otherwise be banned from landfills. This being the case, the present rule and amendments are not a major regulation and no Regulatory Impact Analysis need be conducted.

This amendment was submitted to the Office of Management and Budget (OMB) for review as required by Executive Order 12291.

XI. Regulatory Flexibility Act

Pursuant to the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, whenever an agency is required to publish a general notice of rulemaking for any proposed or final rule; it must prepare and make available for public comment a regulatory flexibility analysis which describes the impact of the rule on small entities (i.e., small businesses, small organizations, and small governmental jurisdictions). The Administrator may instead certify, however, that the rule will not have a significant economic impact on a substantial number of small entities.

This amendment will generally have no adverse economic impact on small entities in that it merely provides another disposal option to entities already subject to regulation under RCRA. Accordingly, I hereby certify that this final regulation will not have a significant economic impact on a substantial number of small entities. This regulation therefore does not require a regulatory flexibility analysis.

Dated: November 12, 1981.

Anne M. Gorsuch,

Administrator.

PART 265—INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

For the reasons set out in the preamble, 40 CFR Part 265 is amended as follows:

1. The authority citation for Part 265 reads as follows:

Authority: Secs. 1006, 2002(a), and 3004, Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6905, 6912(a), and 6924).

2. Section 265.312 is amended by revising paragraph (a) to read as follows:

§ 265.312 Special requirements for ignitable or reactive waste.

(a) Except as provided in paragraphs (b) and (c) of this section and in § 265.316, ignitable or reactive waste must not be placed in a landfill, unless the waste is treated, rendered, or mixed before or immediately after placement in the landfill so that:

(1) The resulting waste, mixture, or dissolution of material no longer meets the definition of ignitable or reactive waste under § 261.21 or 261.23 of this chapter, and

(2) Section 265.17(b) is complied with.

* * * * *

3. Section 265.314 is amended by revising paragraph (b)(2) and by adding paragraph (b)(3) to read as follows:

§ 265.314 Special requirements for liquid waste.

* * * * *

(b) * * *

(2) The container is very small, such as an ampule; or

(3) The container is disposed of in accordance with § 265.316.

* * * * *

4. A new § 265.316 is added to read as follows:

§ 265.316 Disposal of small containers of hazardous waste in overpacked drums (lab packs).

Small containers of hazardous waste in overpacked drums (lab packs) may be placed in a landfill if the following requirements are met:

(a) Hazardous waste must be packaged in non-leaking inside containers. The inside containers must be of a design and constructed of a material that will not react dangerously with, be decomposed by, or be ignited by the waste held therein. Inside containers must be tightly and securely sealed. The inside containers must be of the size and type specified in the Department of Transportation (DOT) hazardous materials regulations (49 CFR Parts 173, 178 and 179), if those regulations specify a particular inside container for the waste.

(b) The inside containers must be overpacked in an open head DOT-specification metal shipping container (49 CFR Parts 178 and 179) of no more than 416-liter (110 gallon) capacity and surrounded by, at a minimum, a sufficient quantity of absorbent material to completely absorb all of the liquid contents of the inside containers. The metal outer container must be full after packing with inside containers and absorbent material.

(c) The absorbent material used must not be capable of reacting dangerously with, being decomposed by, or being ignited by the contents of the inside containers, in accordance with § 265.17(b).

(d) Incompatible wastes, as defined in § 260.10(a) of this chapter, must not be placed in the same outside container.

(e) Reactive waste, other than cyanide- or sulfide-bearing waste as defined in § 261.23(a)(5) of this chapter, must be treated or rendered non-reactive prior to packaging in accordance with paragraphs (a) through (d) of this section. Cyanide- and sulfide-bearing reactive waste may be packaged in accordance with paragraphs (a) through (d) of this section without first being treated or rendered non-reactive.

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APPENDIX D

SUMMARY OF MAJOR DATA ELEMENTS CONTAINED IN COMPUTER DATA BASE FROM THE NATIONAL SURVEY OF RCRA-REGULATED GENERATORS AND MANAGEMENT FACILITIES

APPENDIX D

SUMMARY OF QUESTIONS ASKED ON MAIL SURVEYS

The purpose of this appendix is to combine and summarize the questions asked in the mail surveys, as an aid to analysts who desire an overview of data available from the surveys. Each hazardous waste management facility was asked to fill out a questionnaire concerning the specific waste management process for which it had been sampled, as well as a general questionnaire which sought information regarding all waste management activities at the facility. In addition, Westat surveyed a group of hazardous waste generators, some of whom had filed RCRA Part A applications as well. The data item numbers correspond with the actual question numbers in each survey.

The summarized surveys follow in sequence in the order listed below:

I. Hazardous Waste Generator Questionnaire;

II. Hazardous Waste Treatment, Storage and Disposal (TSD) General Questionnaire;

III. Hazardous Waste Landfill Questionnaire;

IV. Hazardous Waste Surface Impoundment Questionnaire;

V. Hazardous Waste Pile Questionnaire;

VI. Hazardous Waste Incinerator Questionnaire;

VII. Hazardous Waste Land Treatment Questionnaire;

VIII. Hazardous Waste Tank Questionnaire;

IX. Hazardous Waste Container Questionnaire; and

X. Hazardous Waste Underground Injection Well Questionnaire.

I. HAZARDOUS WASTE GENERATOR QUESTIONNAIRE

Facility Identification (1-3)

1-2. Facility EPA I.D., name and address, and contact person.

3. Primary and first three secondary SIC codes.

Waste Generation Activities, Quantities and Characteristics(4-10)

4. 1981 hazardous waste activities: generate, treat, store, dispose, transport or recycle.

5. Hazardous waste generation activities: waste generated before, during and/or after 1981, waste generated but exempt from RCRA for small quantity, farming or recycling, or waste delisted.

6. Reasons for filing RCRA Notification.

7. Total quantity of hazardous waste generated.

8. Quantity generated that will be used, reused, recycled or reclaimed.

9. Reasons for handling waste as hazardous.

10. EPA waste codes for all hazardous wastes generated.

Hazardous Waste Shipped Off Site (11-18)

11-12. Total quantity hazardous waste shipped off site for TSD.

13-15. Quantity and cost of transporting, treating, storing or disposing of wastes shipped off site to facilities owned by other firms.

16. Percentage of total waste shipped off site and sent to other states.

17-18. Identify transporters and find destinations, by quantity, of hazardous waste shipped off site.

Hazardous Waste Use, Reuse, Recycling or Reclamation (UR3) (19-25)

19-21. Facility generated waste that was used, reused, recycled or reclaimed before, during or after 1981.

22. Total quantity of waste generated that was used, reused, or recycled; quantity recycled on site; quantity shipped off site to same company and to other companies.

23. For the five wastes generated in largest quantities and shipped off site for recycling: identify quantities shipped and destinations; storage methods and duration of storage prior to shipment.

II. HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL GENERAL QUESTIONNAIRE

Description of Facility and Waste Processing Technologies (1-9)

1-2. Facility EPA I.D., name and address, and contact person.

3. 1981 hazardous waste activities: generate, treat, store, dispose, transport or recycle.

4. Year waste management operations began.

5. Total area of facility (sq. ft.) and size of areas containing each waste management process.

6. Number of employees, hourly wage and person-hour per week, by occupational categories, by waste management process.

7. Primary and first three secondary SIC codes.

8-9. Facility owned and/or operated privately or by government.

Description and Quantity of Wastes Managed at Facility (10-15)

10. Total quantity of waste (hazardous and nonhazardous) managed on site in 1981.

11. Potential waste (hazardous and nonhazardous) management capacity during 1981.

12. Total quantity of hazardous waste managed on site in 1981.

13. Potential hazardous waste management capacity during 1981.

14. Percentage of hazardous waste transported to TSD operation, by transportation method.

15. Quantities of wastes (hazardous and nonhazardous) and hazardous waste that were or could have been disposed of, treated or stored at the facility in 1981.

Description and Capacity of TSD Technologies, Sources of Hazardous Waste (16-24)

16. Existence and operational status of each type of waste processing technology at the facility in 1981.

17. For each of the 10 largest volumes of hazardous wastes managed at the facility in 1981, the quantity of TSD by each waste processing technology.

18-24. Did facility receive hazardous waste for TSD from off site source in 1981?

If yes, total quantity, quantity by transportation method, quantity from other firms, quantity from RCRA-exempted small generators, SIC codes of five largest off-site generators, off-site hazardous waste analysis methods used.

Groundwater Monitoring (25-29)

25. Methods used to prevent groundwater contamination.

26. Does facility have groundwater monitoring wells?

27. Presence and number of hydraulically up- and down-gradient groundwater monitoring wells.

28. Depth, cost, use and uses of groundwater monitoring wells.

29. Are there geologic/hydrogeologic studies of this facility?

Site Geography (30-44)

30-31. Is facility within one mile of a fault active during past 20,000 years? If so, distance in feet.

33-35. Type, intensity and damage caused by seismic ground motion, if any, experienced by facility.

36. Design or locational criteria used by facility to mitigate ground motion induced damage.

37. Is facility located in a floodplain?

38-39. Type of floodplain and frequency of flooding.

40-42. If facility has been flooded, magnitude of most severe flood and hazardous waste released, if any.

43-44. Types of flood protection used by facility, and reasons for use.

Hazardous Waste Use, Reuse, Recycling or Reclamation (UR3) (45-51)

45-47. Did or will facility generate or receive hazardous waste for UR3 before, during or after 1981?

48. Total quantity of hazardous waste UR3 in 1981; quantity on site, off site (same company), off site (another company).

49. For five principal hazardous wastes generated or received by facility that were shipped off site for UR3 in 1981: description and quantity of waste, EPA I.D. of facilities that received waste, on-site storage methods used and number of days waste was stored prior to shipment.

50-51. For five principal hazardous wastes that facility used, reused, recycled, or reclaimed on site in 1981: description and quantity of waste, methods used for UR3, storage methods used and number of days waste was stored prior to UR3. For waste UR3 in manner constituting disposal, describe process.

Financial Assurance (52-63)

52. Instrument or method used to cover facility closure and/or post-closure costs.

53. Annual administrative charges for maintaining financial assurance.

54-55. Value of collateral, if any, facility owner has put up for financial assurance.

56-57. When, if ever, did facility obtain liability coverage for third-party damages from sudden or nonsudden hazardous waste releases?

58. Was facility upgrade, modification or assessment necessary to obtain liability insurance?

59. How many facilities does insurance cover?

60. **Number and type or liability policies held, amount of coverage, annual cost and amount of deductible for policies.**

61-62. **For how many years prior to the year policy was obtained, if any, does policy cover accidents resulting from sudden or nonsudden hazardous waste releases?**

63. **Does policy cover legal defense costs?**

III. HAZARDOUS WASTE LANDFILL QUESTIONNAIRE

1. Does facility have an active hazardous waste landfill?

Landfill Capacity and Utilization (2-6)

2-3. Design life and remaining operational life of hazardous waste landfill.

4. Total design capacity, capacity used by 1981 and capacity available after 1981 for hazardous waste landfill.

5. Quantity of waste (hazardous and nonhazardous) and hazardous waste that was or could have been disposed of in landfill in 1981.

6. Additional capacity, if any, currently being added to landfill.

Landfill Liner Systems (7-15)

7. Is landfill lined?

8. Composition, permeability and thickness of each layer of landfill liner.

9. Date liner was installed.

10. Cost of installed liner system, by liner type.

11-12. Area and configuration of liner.

13. Source of synthetic liner materials.

14. Liner/waste compatibility information available.

15. Does landfill have liner leak detection system?

Leachate Collection System (16-32)

16. Does landfill have leachate collection system?

17-32. Description and capacity of leachate collection system; treatment, storage and disposal methods for collected leachate.

Physical Characteristics of the Site (33-76)

33. Is any part of landfill operated as an area fill?

34-42. Description and number of lifts, if any, completed or planned at the facility.

43. Has any part of the landfill been operated as a trench fill or cell fill?

44-54. Description of cells, trenches and working cover used in landfill; size, materials, waste/fill ratio.

55. Has final cover been applied to any part of landfill?

56. Composition, permeability and thickness of each layer of final cover.

57. Date of cover installation.

58. Cost of installed cover systems, by type of cover.

59-60. Area of cover and source of synthetic cover materials.

61. Slope of ground surface after landfill closure.

62-66. Description and specifications of run-on control system.

67-71. Description and specifications of run-off control system.

72-75. Description and specification of gas-venting system.

76. Does landfill have gas-to-energy recovery system?

Containerized Waste in Landfills (77-90)

77. Did facility dispose of containerized waste (hazardous or non-hazardous) in 1981?

78-80. Number of containers, quantity of waste and containerized liquid waste or waste with free liquids disposed of in 1981.

81. For five containerized liquid hazardous waste landfilled in greatest quantity prior to 1981: description, liquid content, and physical characteristics of the waste; SIC codes of generators; number of containers landfilled in 1981.

82-85. Number of containers and quantity of containerized waste, if any, that is currently accepted or disposed of in landfill.

86. How is presence of liquid in containers determined?

87. How is presence of liquid in waste determined?

88-89. How does facility handle containers containing liquid wastes?

90. Quantity of bulk liquid landfilled in 1981.

Cost and Pricing (91-111)

91-95. Corporate financial ratios, facility's hazardous waste revenues and costs.

96-102. Ownership status, quantity, cost and value of land and equipment used for hazardous waste landfill.

103-104. Facility costs for operation and maintenance of landfill.

105-109. Pricing policy and total sales for commercial landfilling.

110-111. Facility expenses and depreciation, profit or loss if landfill sold.

On-site Landfilling (112-113)

112-113. On-site hazardous waste generation and landfilling.

IV. HAZARDOUS WASTE SURFACE IMPOUNDMENT QUESTIONNAIRE

1. Facility has active hazardous waste TSD surface impoundment.

Surface Impoundment Capacity and Utilization (2-7)

2-5. Number, utilization and capacity of surface impoundments for TSD of hazardous and nonhazardous waste.

6-7. Expansion of surface impoundment capacity.

Impoundment Design and Construction (8)

8. For each of facility's six largest active hazardous waste surface impoundments: age; remaining life; construction cost; utilization; remaining capacity; configuration; liner; leachate management; and run-on protection.

General Operating Practices (9-16)

9. Waste codes and descriptions of hazardous waste TSD in six largest surface impoundments.

10-15. Presence of sludges and liquid wastes in surface impoundments.

16. For each of six largest hazardous waste surface impoundments: extent and cost of sludge accumulation, dredging and drainage; handling of sludge; description of sludge; cost of sludge TSD; effects of sludge on TSD and wastewater treatment activities.

Cost and Pricing (17-28)

17-20. Ownership status, quantity, cost and value of land used for surface impoundments.

21-23. Quantities, and prices charged for commercial surface impoundment TSD activities, over time.

24-25. Acceptance and prices charged for bulk liquid TSD in surface impoundments.

26-27. Pricing policy relative to waste characteristics and quantity.

On-site Generation and TSD in Surface Impoundments (28-30)

28-29. Proportion of total hazardous waste generated on site.

30. Reasons for having on-site surface impoundment capacity.

V. HAZARDOUS WASTE PILE QUESTIONNAIRE

1. Does facility have active hazardous waste piles?

Waste Pile Capacity and Utilization (2-5)

2-5. Number, utilization, capacity and life of hazardous waste piles.

Waste Pile Descriptions (6-24)

6-8. Number of piles indoors and outdoors.

9-12. Characteristics of run-on and run-off control systems.

13. For smallest, average and 10 largest hazardous waste piles: height; base area and characterisitics; capacity; leak and leachate detection and collection.

14-16. Waste/base compatibility.

17-18. Below-grade hazardous waste piles.

19. Slope of waste pile site.

20-21. Inspection of construction bases.

22-24. Removal of wastes, closure and covering of piles.

Costs and Pricing (25-47)

25-29. Corporate financial ratios, facility's hazardous waste revenues and costs.

30-31. Fees and receipts for commercial hazardous waste pile storage.

32-33. Corporate rates of return on equity and rates.

34. Prices charged for commercial waste pile storage, over time.

35-36. Pricing policy, by waste characteristics and quantity.

37-43. Ownership status, quantity, descriptions, cost and value of land, buildings and equipment used for waste pile operations.

44-45. Annual costs for operating and maintaining hazardous waste piles, by type of cost.

46. Facility depreciation and expenses for fiscal year.

47. Facility profit or loss if waste pile operations sold.

On-Site Hazardous Waste Pile Storage (48-49)

48-49. On-site hazardous waste generation and reasons for on-site storage in waste piles.

VI. HAZARDOUS WASTE INCINERATOR QUESTIONNAIRE

1. Does facility have incinerators that have or will be used to incinerate hazardous waste?

Incinerator Status (2-3)

2. Number of incinerators active, under construction or out of service.

3. Plans for incinerator expansion.

Waste Quantities and Characterisitics (4-7)

4. For each active hazardous waste incinerator: quantity, average feed rate and heating value of hazardous and nonhazardous wastes burned.

5. Number of customers served and number of waste streams burned by incinerator facility.

6. For each type of residual remaining after hazardous waste incineration: quantity, percent hazardous, percent treated on site and percent shipped offsite.

7. For five largest quantities of waste streams incinerated: waste code and description; quantity incinerated; feed rate; heating value and physical form; storage and pretreatment; and hazardous organic constituents.

Incinerator Design and Operating Characteristics (8-10)

8. For each active or under-construction incinerator unit: incinerator type and manufacturer; age and life; utilization and capacity in hours, Btu's and feed rate; largest quantity waste streams; actual feed rate for hazardous and nonhazardous waste; waste feed and residue removal methods; flue gas volume and air pollution control; emergency procedures; and energy recovery.

9. For each combustion chamber in two largest units: volume and air flow rate and control; chamber temperature and residence time; refractory type and thickness; and auxiliary fuel type and use.

10. For the stacks of the two largest units: material; height; diameter; and gas exit temperature and velocity.

Fuels, Materials and Maintenance (11)

11. For the two largest incinerator units: types and totals of supplemental fuels used; daily supplemental fuel use; electrical power used; chemicals used in scrubbers; and type and frequency of routine maintenance.

Capital Investment Costs (12-15)

12-13. Types of costs of original incinerator units and major modifications.

14. Cost and age of items and equipment related to incinerator operation.

15. Depreciation, interest and debt amortization for items 12-14.

Operating and Maintenance (16-17)

16. Operating and maintenance costs, by type.

17. Cost savings due to energy or by-product recovery.

Pricing Policies (18-21)

18-19. Range of prices charged for hazardous waste incineration, by type of waste.

20. Reasons for price differential.

21. Gross sales of incinerator services and recovered energy.

Corporate Financial Data (22-25)

22-25. Corporate financial ratios.

VII. HAZARDOUS WASTE LAND TREATMENT QUESTIONNAIRE

1. Does facility have any hazardous waste land treatment areas?

Land Treatment Site Design Capacity (2-7)

2-3. Area of land treatment units, by type and status.

4-5. Design capacity and operation life of land treatment areas.

6-7. Utilization and capacity of hazardous waste land treatment areas.

Site Design (8-13)

8-13. Location, run-on, run-off and erosion controls of land treatment area.

Soil Characteristics (14-19)

14-18. Soil characteristics and area drainage.

19. Presence and concentration of EPA listed hazardous constituents.

Waste Characteristics (20-22)

20. Types and sources of wastes treated.

21. For the 10 hazardous wastes treated in largest quantities: waste code and description; quantity treated; moisture content and pH; hazardous constituents; and pretreatment.

22. Results of land treatment on hazardous constituents.

Site Operation (23-27)

23-27. Methods and timing of applications of hazardous wastes to land treatment areas.

Monitoring (28-40)

28-30. Run-off collection and analysis.

31-37. Soil core and soil pore water sampling and analysis.

38-40. Frequency and parameters of air monitoring.

Closure Program (41-42)

41-42. Timing and frequency of activities planned for land treatment area after final application of hazardous waste.

Costs and Pricing (43-65)

43-47. Corporate financial ratios, facility's waste management revenues and costs.

48-49. Total sales receipts for commercial land treatment.

50-51. Corporate rates of return on sales and equity.

52-54. Pricing policies and prices changed, over time, for commercial land treatment.

55-61. Ownership status, quantity, cost and value of land, buildings and equipment used for land treatment operation.

62-63. Facility costs for operation and maintenance of land treatment area.

64-65. Facility expenses and depreciation, profit or loss if land treatment operation sold.

On-site Land Treatment (66-67)

66-67. On-site hazardous waste generation and land treatment.

VIII. HAZARDOUS WASTE TANK QUESTIONNAIRE

1. Facility has tanks used for accumulation (<90 days), storage and/or treatment of hazardous wastes.

Tank Capacity and Utilization (2-20)

2. Number of tanks at facility.

3. Facility generated hazardous waste.

4. Wastes accumulated under RCRA 90-day rule.

5-7. Number of tanks used for hazardous waste storage.

8-9. Quantity of hazardous waste in storage tanks at beginning and end of 1981.

10. Average duration of hazardous waste storage.

11-15. Number, capacity and utilization of tanks operating under RCRA wastewater treatment tank exemption.

16-20. Number, capacity and utilization of tanks used for treating hazardous wastes (not under wastewater treatment exemption).

Tank Description Sheets (21:T1-29)

21. Description of each hazardous waste treatment and/or storage tank at facility (excluding 90-day accumulation tanks).

T1-T4. Tank type, capacity, average and maximum utilization.

T5-T6. Age and life of tank.

T7. Characteristics of wastes stored or treated in tank.

T8-T11. Tank location, configuration (open or closed-topped, above or below ground) and air emission control.

T12-T14. Frequency of inspection and other integrity monitoring.

T15-T17. Construction material for tank and liner.

T18-T22. Presence and capacity of secondary containment and safety systems.

T23-T27. Wastewater treatment processes used (if any) and characteristics of wastewater streams.

T28. Tank received hazardous wastewater generated by other facilities.

T29. Cost and age of tank, ancillary equipment and secondary containment for tank and ancillary equipment.

Corporate Financial Information (22-25)

22-25. Corporate financial ratios and facility solid waste management revenues.

Costs and Pricing for Storage (26-33)

26. Cost of land, buildings and equipment related to hazardous waste storage tanks.

27. Cost of operating and maintaining storage tanks.

28-32. Prices and pricing policies for commercial tank storage of hazardous waste, and total annual receipts.

33. Gain or loss if tank waste storage operation sold.

Costs and Pricing for Treatment Services (34-41)

34. Cost of land, buildings and equipment related to hazardous waste tank treatment.

35. Cost of operating and maintaining treatment tanks.

36-40. Prices and pricing policies for commercial tank treatment of hazardous waste, and total annual receipts.

41. Gain or loss if tank waste treatment operation sold.

18-22. Prices and pricing policies for commercial container storage of hazardous wastes, and annual receipts.

23. Gain or loss if container storage operation sold.

IX. HAZARDOUS WASTE CONTAINER QUESTIONNAIRE

1. Facility uses containers for storing or accumulating hazardous waste.

Storage and Accumulation in Containers (2-10)

2. Number of container storage or accumulation areas.

3. Does facility generate hazardous waste?

4-5. Number of hazardous waste container accumulation areas (stored <90 days).

6-7. Number of hazardous waste storage areas.

8-9. Quantity of containerized waste in storage at beginning and end of 1981.

10. Duration of hazardous waste storage in containers.

Container Storage Area Description Sheet (11:C1-C12)

11. Description of each hazardous waste container storage area at facility (excepting those operating under the 90-day accumulation rule).

C1-C3. Characteristics, typical and maximum quantities of hazardous wastes kept in container storage areas.

C4-C8. Description and cost of container storage area base material, run-off control and secondary containment.

C10. Distance between this container area and nearest off-site structure.

C11. Number, cost and types of containers used in this area.

Corporate Financial Information (12-15)

12-15. Corporate financial ratios and facility solid waste management revenues.

Costs and Pricing for Storage Services (16-23)

16. Cost of land, buildings and equipment related to hazardous waste storage containers.

17. Cost of operating and maintaining storage containers.

On-site Well Injection (27-28)

27-28. On-site hazardous waste generation and deep well injection.

24-25. For five wastes generated in largest quantities and recycled on site: methods and quantities of use, reuse, recycling or reclamation; types and duration of storage prior to recycling; description of recycling methods, if any, that constituted disposal.

Wastewater Treatment and 90-Day Accumulator Exemptions (26-45)

26-28. Number and design capacity of tanks operating under the wastewater treatment system exemption.

29-31. Number of storage areas and average quantity of waste stored under the 90-day accumulation exemption.

32-33. Location and supervision of waste accumulation areas.

34. Percentage of waste accumulated under the 90-day rule in tanks, 55-gallon containers or other containers.

35-36. Number and capacity of tanks used for 90-day accumulation.

37-38. Number and capacity of containers areas used for 90-day accumulation.

39. Was 90-day accumulated waste processed on-site in treatment, disposal, use, reuse, recycling or reclamation.

40. Was 90-day accumulated waste shipped off site for TSD or recycling?

41-42. Normal and optimum size for waste shipments.

43-44. Number of days to generate optimum sized waste shipment; number of times it was necessary to ship smaller than optimum quantities to meet 90-day accumulator exemption requirements.

45-46. For waste exchange: Chemical Abstract Registry numbers for each hazardous waste stream generated.

X. HAZARDOUS WASTE UNDERGROUND INJECTION WELL QUESTIONNAIRE

1. Does facility have active hazardous waste disposal injection well?

Well Capacity and Utilization (2-4)

2-3. Number, type and characteristics of injection wells and their sites.

4. Responses to the following questions for wells that (a) dispose below deepest groundwater, (b) dispose into groundwater, (c) dispose above groundwater, or (d) operate in another manner: quantity of hazardous waste injected; capacity; average and maximum injection rate; number of days of operation; and 10 greatest volume wastes.

Intermediate Storage and Treatment (5-9)

5-7. Presence, methods and capacity of on-site intermediate waste storage.

8-9. Presence and methods of on-site waste treatment prior to injection.

Costs and Pricing (10-26)

10-12. Corporate assets/liabilities, debt/equity and waste revenues/total revenues ratios.

13. Average unit cost to inject hazardous wastes.

14-17. Ownership status and cost of land, buildings and equipment related to hazardous waste injection wells.

18-19. Annual injection well operation and maintenance costs.

20-22. Source and amount of sales receipts for commercial injection well activities.

23-24. Prices and pricing policies for commercial hazardous waste injection well activities.

25-26. Facility depreciation and total expenses, net loss or gain if injection well operation sold.